PRODUCT ENGINEERING

GEORGE F. NORDENHOLT, EDITOR

Engineers to the Rescue

PAYROLLS have expanded enormously, thanks partly to business recovery and partly to the moral suasion of labor unionism. Product costs have gone up with them to an alarming extent. If markets are not to dry up because of buying resistance some way must be found to offset higher labor costs.

Here is where engineering design can step in and prove its worth. Every part of the product must be analyzed for possible economies, and every production operation must be scrutinized to determine the need for it. The engineering department and the shop must get their heads together to see what savings they can work out between them. Exceptional engineering ability and judgment is required as savings must not be made at the expense of quality. Often more expensive materials must be used, controls or other features added. But it must be accomplished without increased total cost.

Excellent results of this sort have been secured in many companies. As an example, the substitution of welded fabrication for large castings in huge generators built by the electrical manufacturers got final costs within reason. On large units the savings are impressive, but small savings on many small units add up just as impressively in the long run.

This number of *Product Engineering* is entirely devoted to the annual roundup of design trends, and materials and parts applications. Engineers everywhere, in all sorts of industries, have supplied complete data on what they are doing to make their products better, cheaper, more salable. Progressive companies submitted photographs of their latest designs with blueprints or design features. These form an impressive part of the presentation.

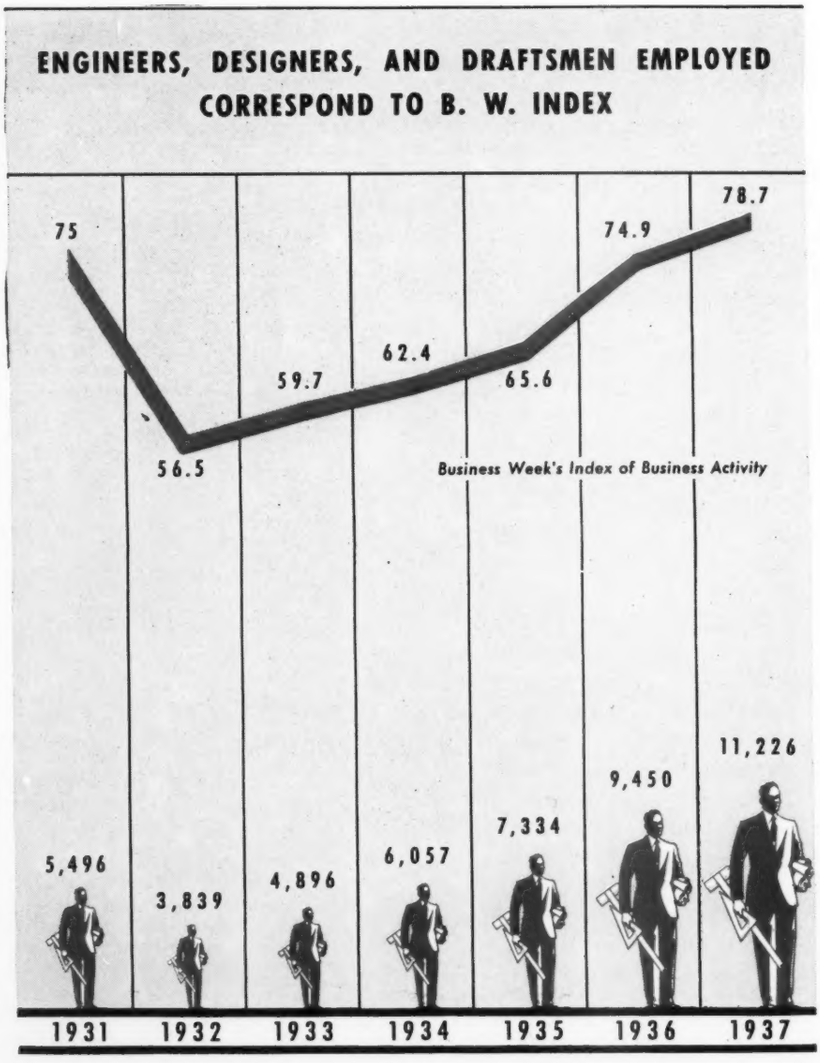
The data collected in these annual numbers are studied carefully by product engineers all over the country because they indicate trends and permit a man to determine quickly whether he is ahead of the general procession or behind it. Also, he can tell just where he is falling short, and get a pretty clear idea what he should do to catch up.

PRODUCT ENGINEERING acknowledges deep indebtedness to the engineers of more than five hundred companies for the reports on which the trend figures are based. Without their hearty cooperation the task of assembling the information contained in this number would have been impossible. At the same time its editors and publishers take pride in being able to render so important a service to readers at a time when it is so vitally needed. Service of this sort is in the tradition of the paper and constitutes a large part of its claim to recognition as an indispensable tool of the designing engineer.

Activities and Trends

in Engineering Design

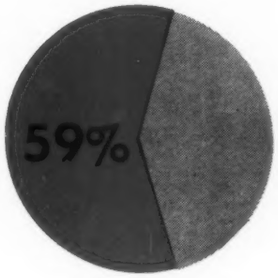
Based on reports from the chief engineers or other responsible executives of 506 manufacturers of machinery and metal products and illustrated with modern designs that reflect the trends in use and applications of various materials



IN THIS REPORT of our 1937 survey, only the most significant trends-figures are given for each of seven divisions and the totals for all items are tabulated in a summary. With reference to the figures on general activity as shown on this page, 1937 shows some drop in the rate of increase in the number of engineering designers employed (29 per cent increase for 1936; 18.8 per cent increase for 1937). However, the numerical increase for 1937 is 1,776 which is only slightly less than the increase of 2,116 reported in 1936. That the curve practically parallels *Business Week's* index of business activity is to be expected.

Of the 506 reporting companies, 43 per cent expect to increase their engineering design activities during the coming year. Of the 290 companies that increased their engineering staff during the past year, 74 per cent expect to expand their engineering departments still further during the coming year. More than 59 per cent of these 506 companies reported that they are now developing new designs.

A study of the various tabulations on the following pages brings out some interesting facts. Designing for flame-cut parts is steadily increasing



Of the 506 reporting companies, 59 per cent have developed new models or redesigned old products during the past year, in many instances whole lines of products having been redesigned

Of the 290 companies that increased their engineering staffs during the past year, 74 per cent expect to expand engineering activities further during the coming year

and, naturally, fusion welding is also on the increase. Particularly in the fields of light machinery and non-mechanical products such as radios, refrigerators and sheet metal design, there has been a remarkable growth in the use of resistance welding. As is to be expected, the use of stampings shows a corresponding increase. Quite a number of designers of medium and even heavy machinery reported a more extensive use of resistance welding and stampings.

Naturally, with the wider adoption of welded construction there is the greater use of tubular construction, the feasibility of which had formerly been greatly limited by the difficulty of designing the joint. Welding solved the problem.

To the engineering designer, the attention that is being given to variable-speed drives is undoubtedly more significant than the driving medium used. This trend reflects the big demand for maximum efficiency of operation in all types of production machinery. Such high efficiency often cannot be obtained without some form of variable-speed transmission in order that the machine can be run at the maximum permissible speed for every different condition.

Hydraulic operation, which has been on the increase for a number of years, is finding many applications in new fields. A further investigation of the figures reported indicated that the possibility of interlocking hydraulic and electric circuits is a large contributing factor.

Progress in the adoption of electronic controls seems to be relatively slow, judged by the figures reported. Undoubtedly the greatest progress in this field has been the wide adoption of electronic controls for resistance welding machines. Results have been remarkable. But, with reference to the use of photoelectric tubes, progress is much slower.

Among the materials of construction, the trend continues away from the cheaper plain materials and to a more extensive use of alloys and the costlier metals. Stainless steels show the greatest increase. Low and high alloy steels are being shown preference to plain carbon steel, while alloy cast iron and malleable iron are supplanting plain gray iron. Being already quite well established, aluminum and zinc die-castings do not show a greatly increased use, but rank high as materials of construction in a great many fields.

Chemical rust-proofing and chemical surface preparation continue steadily on the increase. The significant fact here is that these processes are being applied to much larger pieces. Size no longer seems to be a limiting factor in the application of such processes to metal parts.

Modern design practice is emphasizing more and more the necessity for quality in design. The engineer is expected to use the best materials in the most economical manner.

Space does not permit a more detailed summary at this time. However, with the facts and figures uncovered by this survey as a basis, and with data and information procured from further investigations, comprehensive articles on the various phases of this survey are being prepared and will appear in future numbers of *Product Engineering.*

To the more than 500 engineering executives who furnished the data for this survey, and to the many companies who so willingly supplied complete details of their products for presentation in this number, we express our thanks and gratitude.

Unfortunately, space does not permit presenting all of the "Designs of '37" that were received. However, the many designs omitted from this number will be presented in the forthcoming issues.

Group One

SMALL MACHINERY

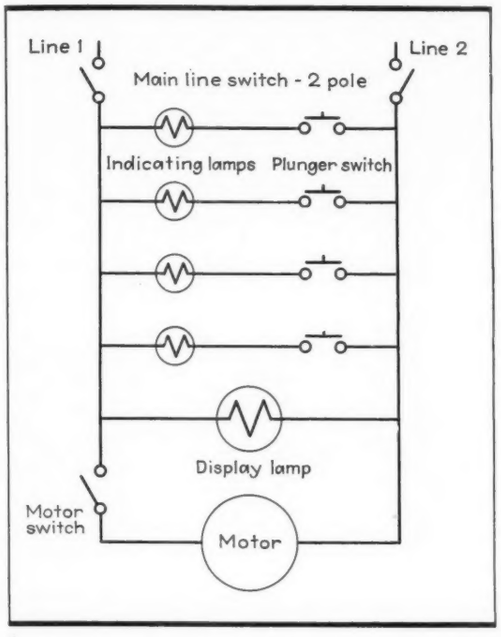
Powered lawn mowers, motorcycle engines, meat slicers, chain hoists, small turbines, portable electric tools, small pumps

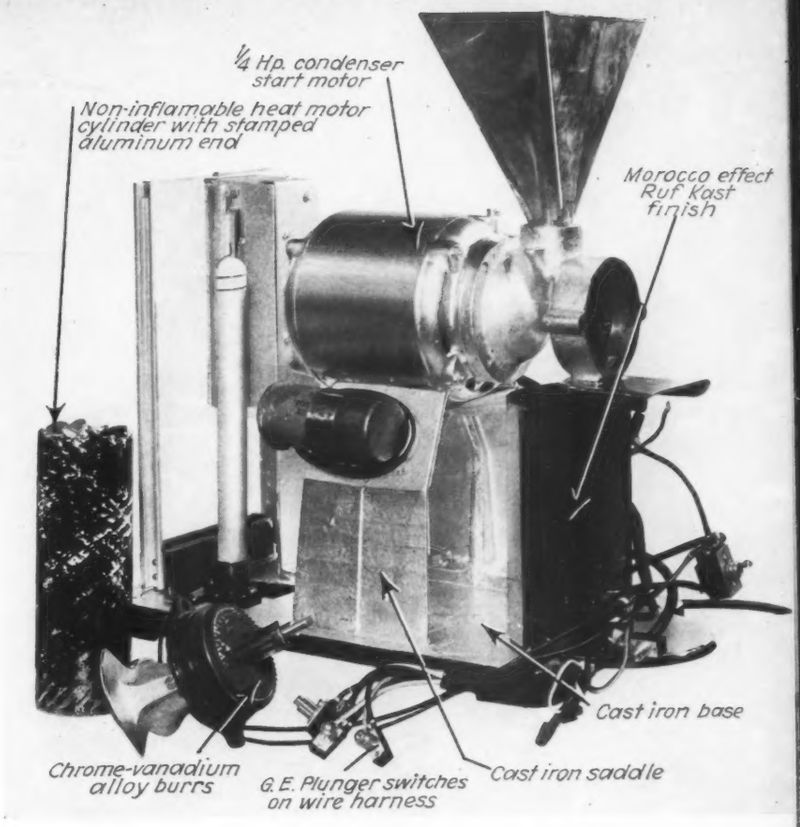
119 companies reporting

	Per Cent Using	Per Cent Increase
TYPES OF CONSTRUCTION		
Stampings	69	24
Die-castings	53	18
Molded plastics	48	14
Sand castings	85	14
Fusion welding	30	13
Resistance welding	36	10
Drop forgings	42	9
Flame cut parts	19	8
Drawn sections	32	6
Tubular construction	28	5
Roll formed sheet	21	4
DRIVES AND CONTROLS		
V-belts	54	19
Gears	49	8
Special motors	24.5	6
Motor speed reducers	22	6
Magnetic controls	33	5
Separate speed reducers	30	5
Chains	25	5
Variable-speed drives	17	4
Limit switches	21	4
Thermostatic controls	25	4
BEARINGS AND LUBRICATION		
Ball or roller	69	22
Grease-sealed	46	15
"Oilless"	45	8
Needle	24	7
Grease gun fittings	37	5
Oil circulating pumps	10	5
Unit bearing seals	17	4
Sleeve type	50	2
TYPES OF FASTENINGS		
Self-tapping screws	36	10
Hollow head screws	53	9
Nut locking devices	50	7
Drive screws	35	3
MATERIALS OF CONSTRUCTION		
Heat-treated alloy steel	52	15
Alloy cast iron	36	13
Copper, brass, bronze	73	10
Aluminum	68	10
Stainless steel	51	9
Zinc	32	9
FINISHES		
Chromium plating	46	14
Cadmium plating	57	12
Organic coatings	63	9
Nickel plating	35	4
Anodic coating	12	4
Chemical coatings	9	3

Automatic Flash Indicates Size of Grind

Plunger switches start electric motor and complete circuit to a lamp that indicates size of grind. Switches are wired on harness with colored leads to facilitate placement in housing



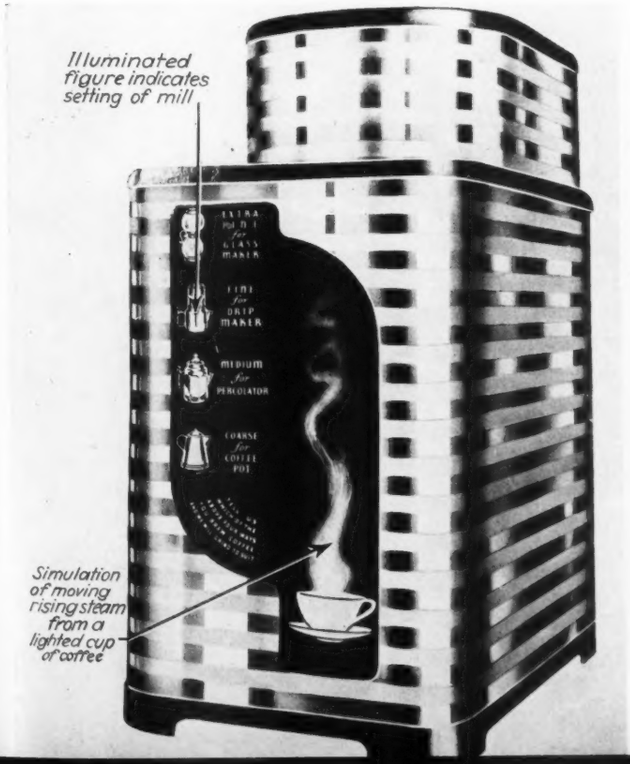

¼ Hp. condenser start motor
Non-inflamable heat motor cylinder with stamped aluminum end
Morocco effect Ruf Kast finish
Cast iron base
Chrome-vanadium alloy burrs
G.E. Plunger switches on wire harness
Cast iron saddle

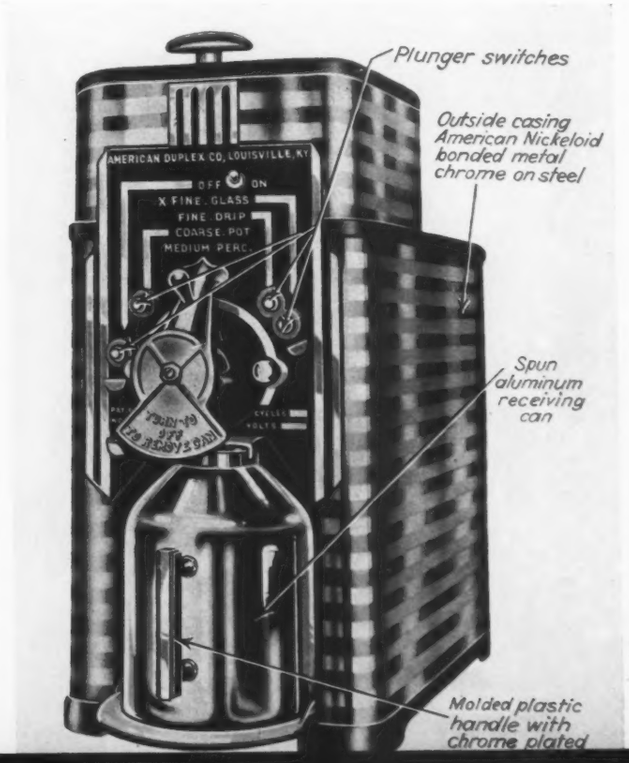
HEAT MOTOR consisting of a non-inflammable tube with a wheel-vane end and a tube lamp, plus two glass panels are employed to get the illusion of rising steam coming from a cup of coffee in this grinding mill manufactured by American Duplex Company.

Electric motor has no brushes to wear out, it is a specially wound ¼ hp. condenser start type. Motor saddle and the grinder case fit on rabbeted end of motor and are cast iron. The material in the grinding burrs is a special alloy of chrome and vanadium developed by the Vanadium Corporation of America to resist wear and to remain sharp and hard.

CAST IRON PARTS of mill are finished with Berry Bros. Ruf Kast to obtain a morocco effect. Outside casing is American Nickeloid bonded metals, chrome on steel, with alternate brushed and polished stripes.

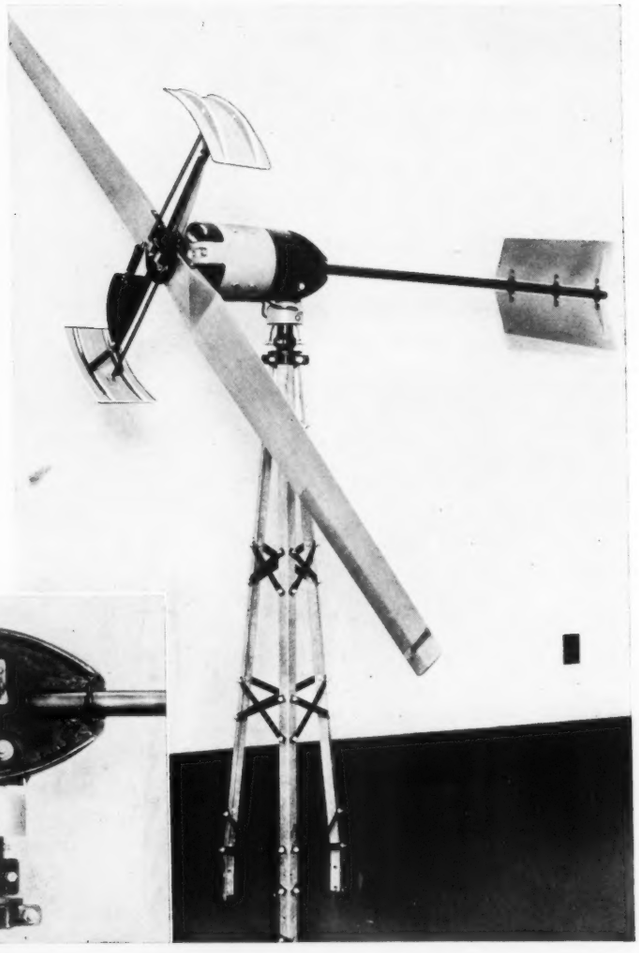
INDEX CAM LEVER depresses plunger switch to start motor, sets grinding burrs at proper spacing and locks receiving can in place until index is turned "off." Lamp in plunger switch circuit indicates size of grind.

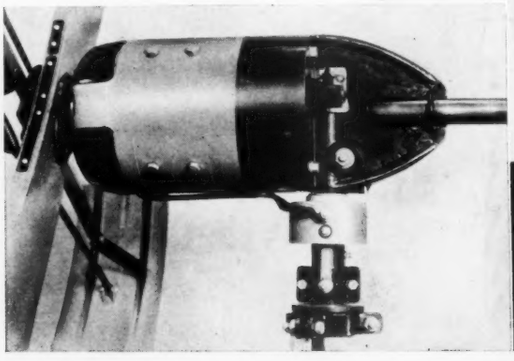


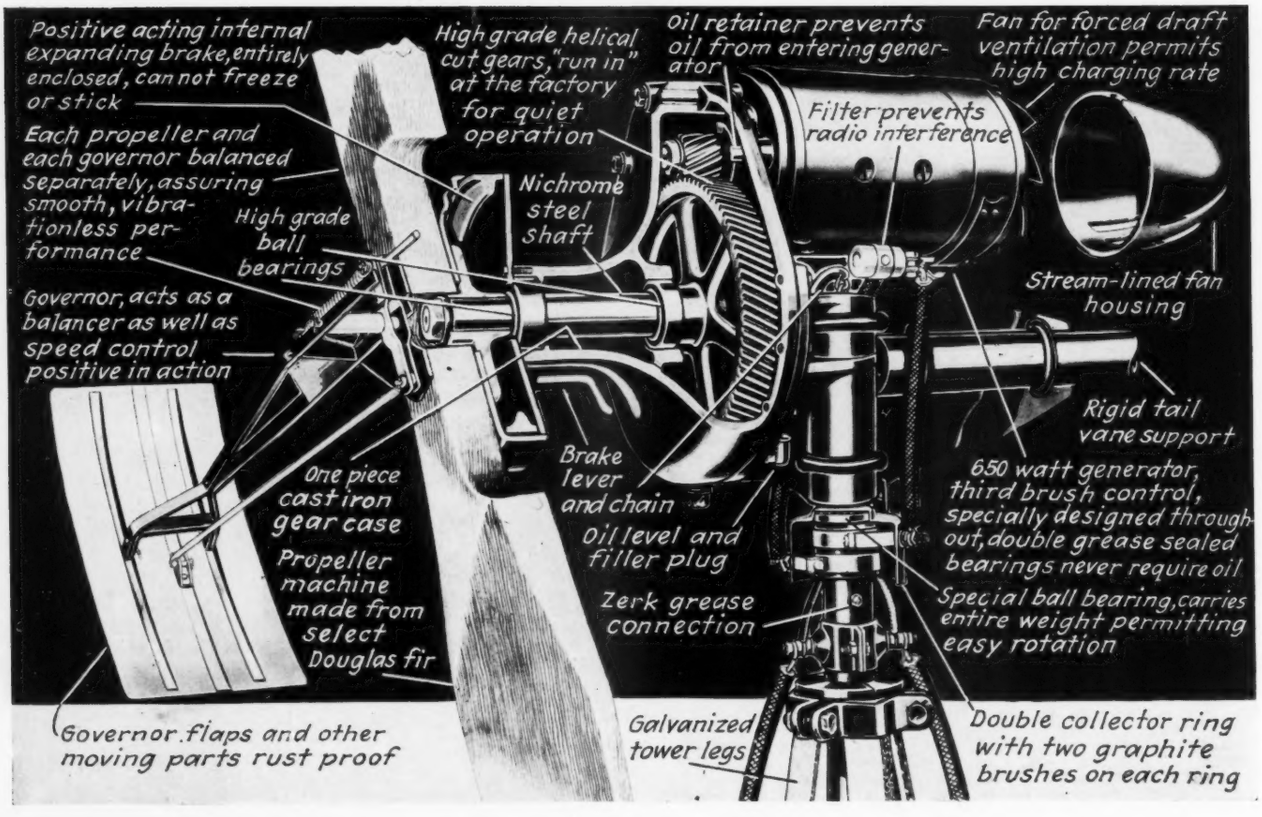

Plunger switches
Outside casing American Nickeloid bonded metal chrome on steel
Spun aluminum receiving can
Molded plastic handle with chrome plated
AMERICAN DUPLEX CO, LOUISVILLE, KY
OFF ON
X FINE - GLASS
FINE - DRIP
COARSE - POT
MEDIUM - PERC

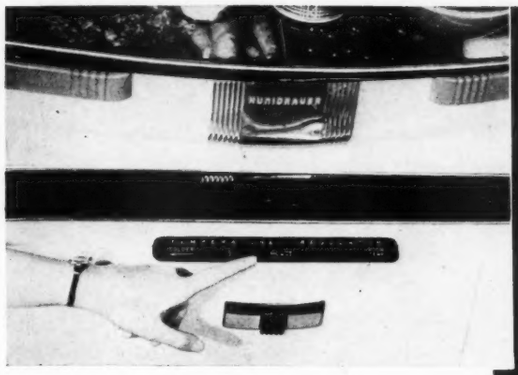
Automatic Governor Limits Windmill Generator Speed

DIRECT DRIVE 500 watt generator manufactured by Wincharger Corporation, with built-in brake. Douglas fir propeller has a pitched face for easy starting, is triple coated with marine paint, and blade edges are protected by copper armor and copper tips. In a high wind centrifugal force causes the flaps of the automatic governor to swing out and act as an air brake maintaining constant propeller speed. Unit is furnished with 5 ft. legs for mounting on tower. Cutaway section shows 650 watt generating set, with a 6 to 1 gear drive fully inclosed and running in an oil bath.






Positive acting internal expanding brake, entirely enclosed, can not freeze or stick
Each propeller and each governor balanced separately, assuring smooth, vibrationless performance
Governor, acts as a balancer as well as speed control positive in action
High grade helical cut gears, "run in" at the factory for quiet operation
High grade ball bearings
Nichrome steel shaft
Oil retainer prevents oil from entering generator
Filter prevents radio interference
Fan for forced draft ventilation permits high charging rate
Stream-lined fan housing
Rigid tail vane support
650 watt generator, third brush control, specially designed throughout, double grease sealed bearings never require oil
Special ball bearing, carries entire weight permitting easy rotation
Double collector ring with two graphite brushes on each ring
Brake lever and chain
Oil level and filler plug
Zerk grease connection
One piece cast iron gear case
Propeller machine made from select Douglas fir
Governor flaps and other moving parts rust proof
Galvanized tower legs



FINGER-TIP DIAL indicates desired temperature of food compartment and also the position of temperature control. Glass top humidrawer permits visible inspection of contents without necessity of pulling out tray.

Finger Pressure Releases Frozen Refrigerator Trays

Innovations incorporated in new Westinghouse refrigerator result from many consumer kitchen tests

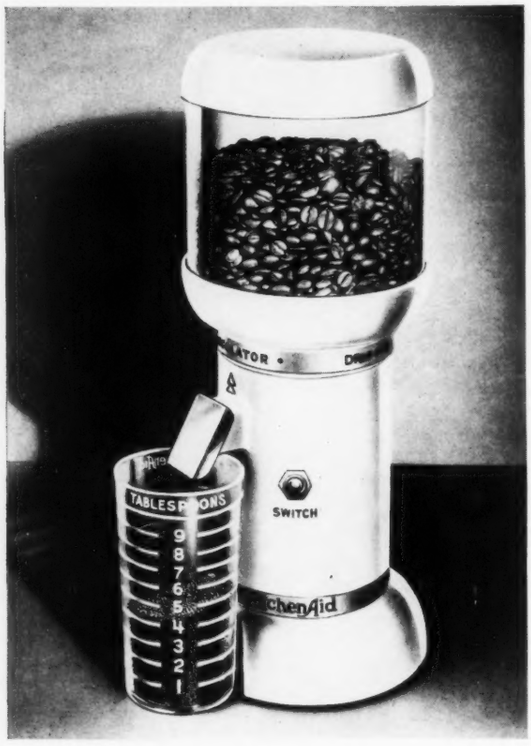
CABINET is styled with flowing lines, rounded corners and trimmed with polished chromium fittings. Models are finished in either Dulux synthetic lacquer or fired porcelain enamel.

CLOSELY SPACED GRIDS on shelves give improved footing for dishes and jars. Food saving dishes provide storage for left-overs. These dishes are impervious to temperature changes and can be placed in an oven if desired. A fold-away shelf can be tilted up against side of compartment to make room for tall bottles.

TRAYS in freezing compartment are provided with lifts for loosening from shelf by finger pressures. Food compartment has adjustable height shelves to accommodate various size containers. Meat storage compartment has a cover for conserving moisture, which, in addition to the low temperature, is necessary for proper preservation of meats.

Coffee Mill of Compact Design

ROTATING PARTS are supported in graphite bronze bearings, wick lubricated. Electric motor is of the universal type. The Kitchen Aid Coffee Mill is finished in Hi-Bake Dulux, and exterior parts are aluminum with anodic finish. The unit was designed by Douglass Houser of The Hobart Manufacturing Company and Egmont Arens.



Planetary Drive for Food Mixer

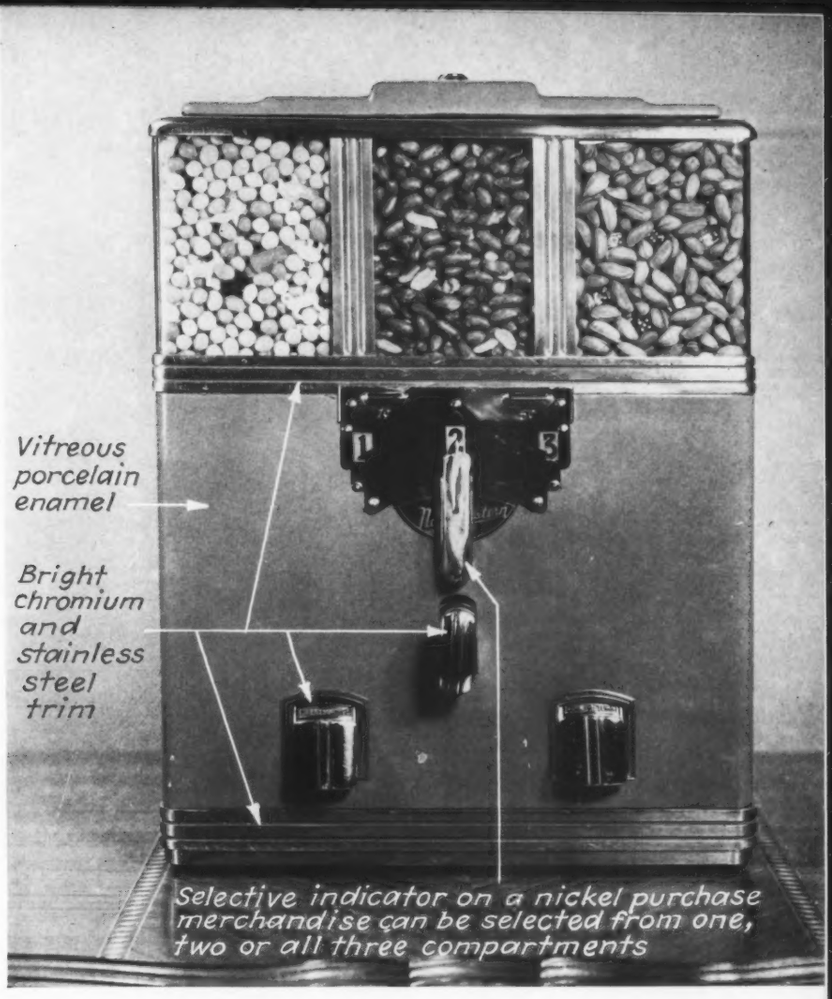
PLANETARY AND ROTARY mechanism revolve beater around the bowl and also around the beater axis in mixing machine designed by Egmont Arens and made by The Hobart Manufacturing Company. Motor is governor controlled and is of the universal type. Transmission housing tilts back giving access to all parts of bowl and beater and also to enable easy changing of beaters and whips. Rear gear is graphite bronze and is wick lubricated. Gear at the worm end is ball bearing mounted and grease packed. Finish is a Hi-Bake Dulux. Drip cup and band around drive case are brass chromium plated. Lever knobs are plastic molded with steel inserts.

Quality Materials Contribute To Life and Accuracy of Register

CONSERVATION of counter space, simplified mechanical construction and good appearance feature cash register made by Ohmer Register Company. The side frames which carry the register mechanism are made from flat steel tied together with steel bars. Operating levers, gears, cams and shafts are made of high-grade alloy nickel, chrome-vanadium, or chrome-molybdenum steels, heat-treated to definite specifications to obtain strength and wear-resisting qualities. Shaft bearings are made from high-grade "Elephant" brand bronze bearing material, Tobin Bronze or hardened steel. Die-castings of zinc or aluminum are used for parts which require accuracy, strength and duplication. Printing type wheels mounted on a stationary shaft are made of hardened steel, their type faces are ground to insure concentricity and a good printing surface. Hand setting lever assemblies are built up of steel parts riveted together. Setting gears and sectors are hardened to prevent wear.

Compartment Bulk Vending Machine

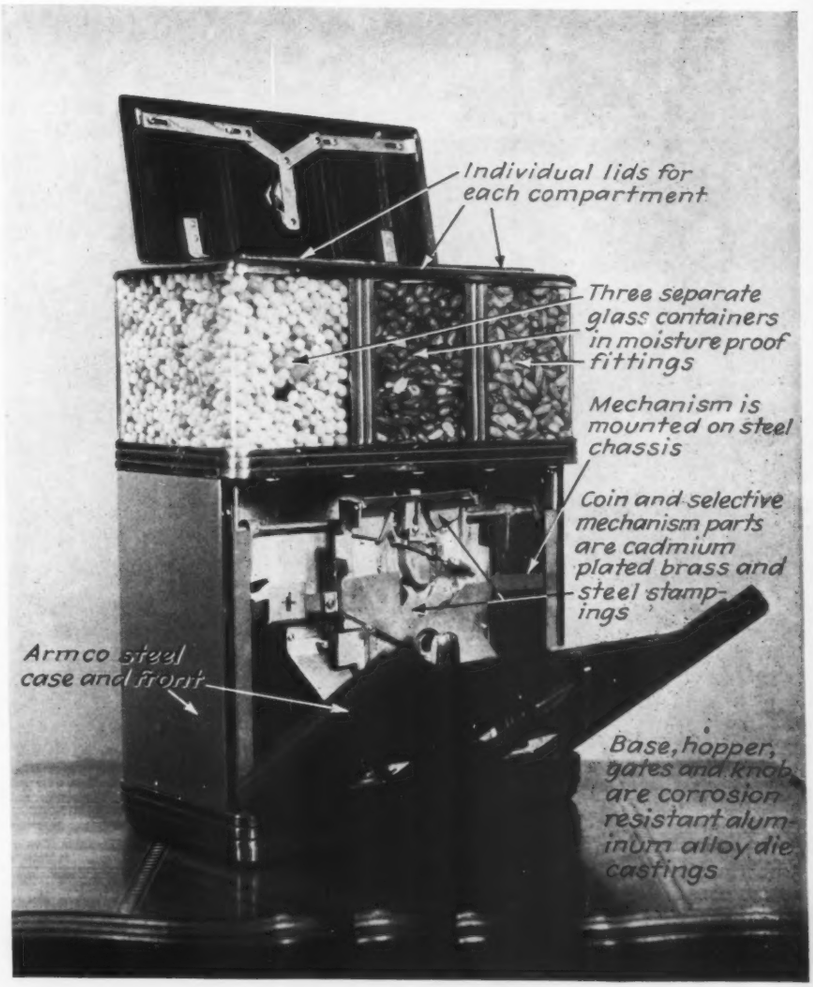
Slots for both pennies and nickels. Arrangement permits a selection of merchandise from one, two or all three compartments on a nickel purchase. Fittings are moisture proof.

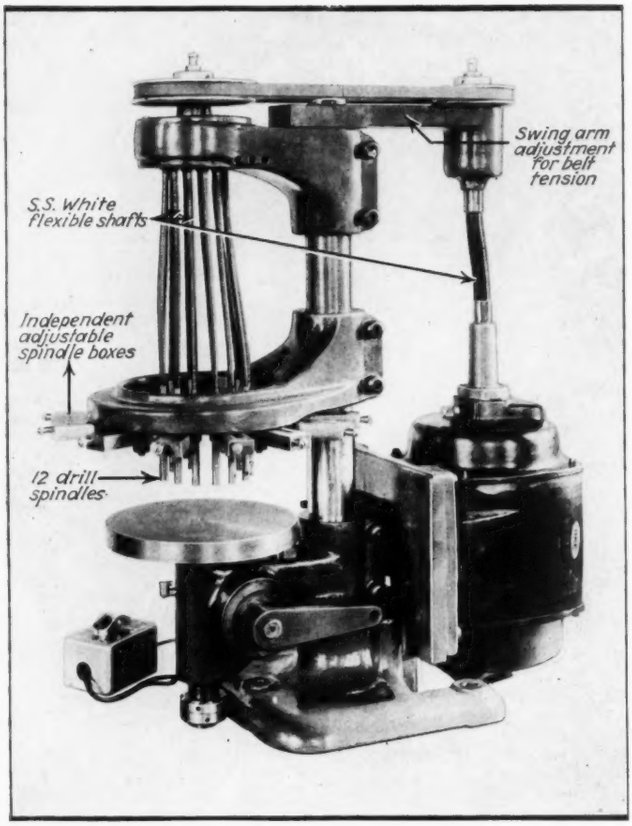

Vitreous porcelain enamel
Bright chromium and stainless steel trim
Selective indicator on a nickel purchase merchandise can be selected from one, two or all three compartments

INDICATOR can be moved to select merchandise from the compartments identified on instruction plate by numbers. Handle cannot be turned to deliver goods unless indicator points to a number. For a penny purchase customer can select merchandise from only one compartment. But on a nickel purchase customer can select merchandise from one, two or all three compartments.

The separate glass containers of the Triselector built by the Northwestern Corporation are mounted in moisture-proof fittings and each is covered with an individual lid.

CHASSIS built up of steel stampings is fastened to the base and supports the coin receiving, the indexing and selecting, and also the goods delivering apparatus. A case with a front which swings downward when unlocked houses the chassis and mechanical parts. Case and front are 16 gage Armco steel, finished inside and out with vitreous porcelain enamel. A sliding lever locks the case to the base. When machine is opened the complete mechanism is fully exposed. Non-working parts which include base, merchandise hopper, chute gates, and knob are diecastings made of special corrosion-resistant aluminum alloy. Coin and selective mechanism are made of heavy brass and steel stampings all cadmium plated. Entire machine is rustproof to withstand atmospheric conditions. Both top and front are protected with brass barrel cylinder locks.

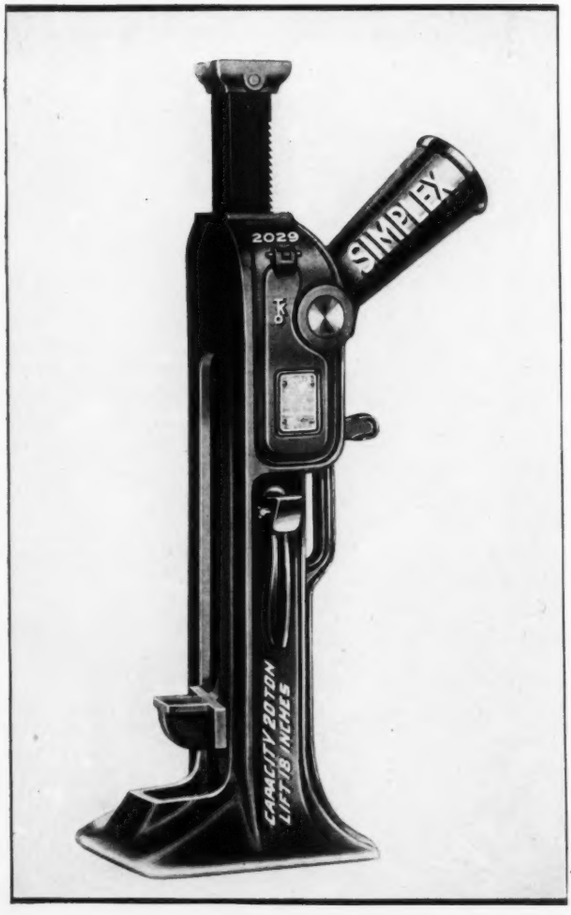

Individual lids for each compartment
Three separate glass containers in moisture proof fittings
Mechanism is mounted on steel chassis
Coin and selective mechanism parts are cadmium plated brass and steel stampings
Armco steel case and front
Base, hopper, gates and knob are corrosion resistant aluminum alloy die castings


Swing arm adjustment for belt tension
S.S. White flexible shafts
Independent adjustable spindle boxes
12 drill spindles

Flexible Shafts Solve Adjustable Drive Problem

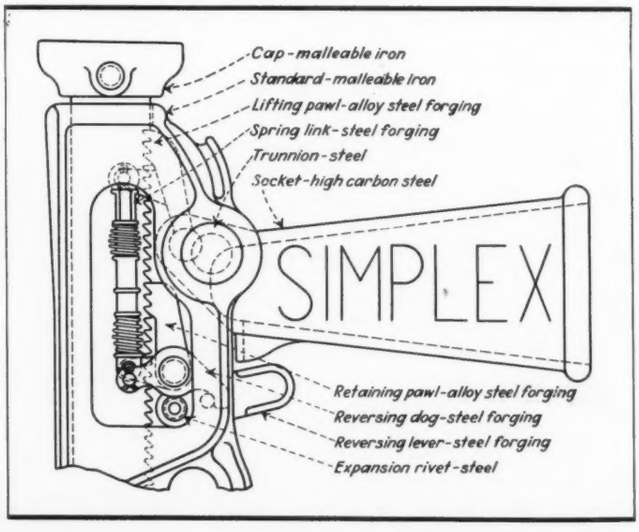
FLEXIBLE SHAFTS for main drive and also for unit spindle drives solve problem of providing adjustable driving sheave and independent shifting of drill positions. Made by Automatic Machine Co., for drilling one to twelve holes simultaneously. Main drive from motor to small pulley is $\frac{3}{8}$ in. diam. flexible shaft and casing with two half-round fittings attached; over-all length of shaft is $10\frac{3}{4}$ in. The half-round fittings provide a sliding connection to take care of any relative change in length between shaft and casing when the combination is flexed. Casing is a Parkerized metallic two-wire type, 0.480 in. I.D. and 0.750 in. O.D. Spindle driving shafts are 0.150 in. diam. and drive through formed ends swaged square approximately 25/32 in. long. The ends are free to move axially in their receptacles. This style of end-joint eliminates two end fittings per shaft.

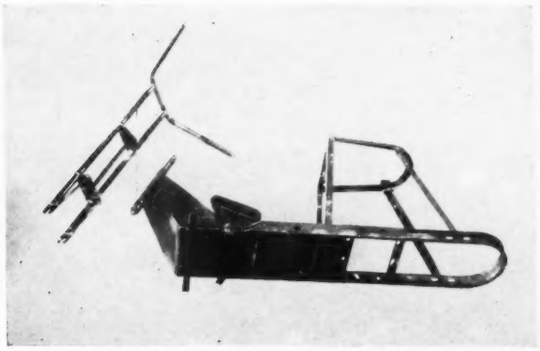
Casings over the spindle driving shaft are $10\frac{1}{8}$ in. long overall and are of Parkerized metallic four-wire construction without end fittings. Attachment of casing to the machine members is made by merely clamping it in place with a set screw.



Stronger Materials Increase Efficiency

HIGH-ALLOY HEAT-TREATED STEEL in lifting and retaining pawls makes it possible to build jacks with fine teeth so that effort required for operation is decreased. Material in other parts is selected to stand up under the severe outdoor service encountered in railroad maintenance. This new 20-ton jack built by Templeton, Kenley & Company also has drop type handles. The socket is elliptical having long axis vertical to receive lever pole, the end of which is formed with grain of wood parallel to long axis. Jack is $28\frac{1}{2}$ in. high, weighs 102 lb., and has 18 in. lifting stroke.


Cap - malleable iron
Standard - malleable iron
Lifting pawl - alloy steel forging
Spring link - steel forging
Trunnion - steel
Socket - high carbon steel
SIMPLEX
Retaining pawl - alloy steel forging
Reversing dog - steel forging
Reversing lever - steel forging
Expansion rivet - steel

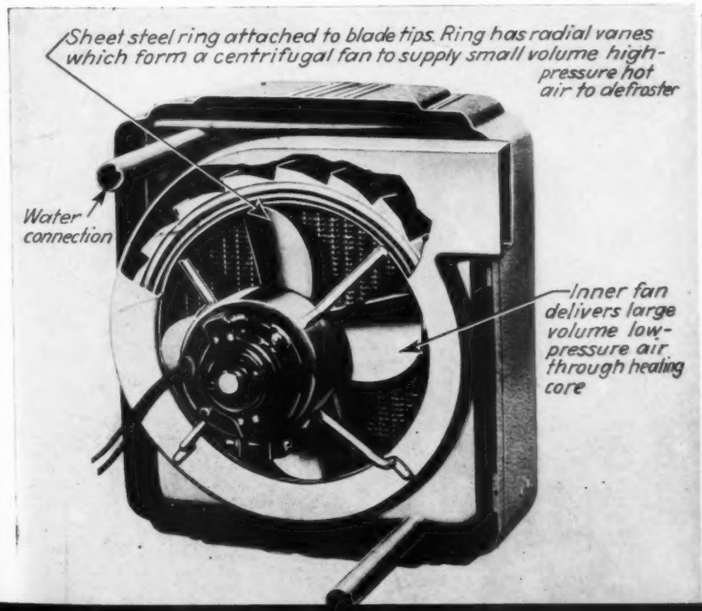


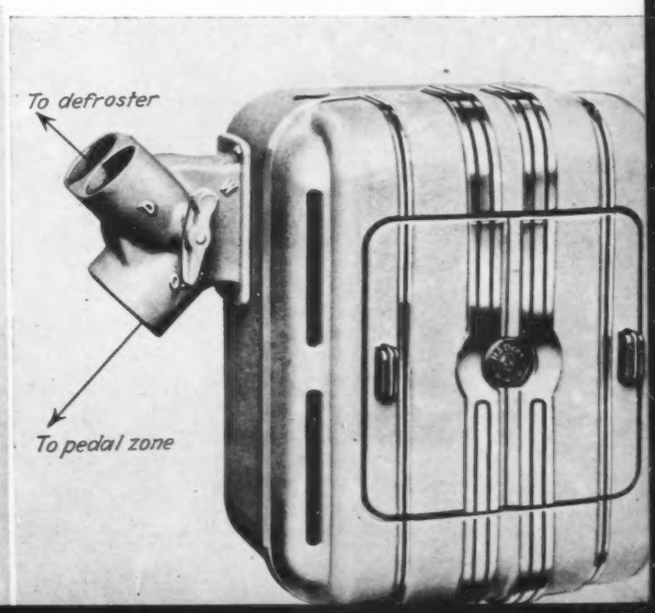
Jig-Welded 33-Piece Frame

ARC-WELDED FRAME is made of 33 pieces which include channels, angles and sheets. All pieces of frame are located in one master jig, tacked in place and finish welded. Front fork consists of 16 pieces brazed together. Steering head has double bars of seamless tubing. Drive from engine disk clutch to rear wheel sprocket is roller chain. Engine is 1 hp. of four-cycle type and has kick starter. Steel disk wheels are each mounted on two taper roller bearings. Brake on rear wheel is external contracting type. Non-skid balloon tires have removable inner tubes. Machine is built by Cushman Motor Works and is furnished in a choice of colors.

Fan Within a Fan for Double-Duty Delivery

SINGLE ROTATING UNIT furnishes both a low volume of high pressure air for windshield defrosting and also a large volume of low pressure air for car heating. This automobile fan was designed by Liberty Foundries Company. An inner propeller-type fan, mounted on the motor shaft, forces a large volume of air at low pressure through the heating core connected to automobile water radiator system. Attached to the outside edges of the inner fan blades, so as to form one unit, is a centrifugal fan of the radial vane type incased in a volute shaped housing. This outer fan is a sheet ring which is flat in the plane of rotation except for a concentric bead for increasing stiffness and for reducing vibration thereby promoting quiet operation. To simplify the construction further the radial vanes and steel ring are formed in one piece. The centrifugal fan performs the extra service of providing hot blasts to windshield defroster, and to the cold zone of car around the pedals, at a pressure sufficiently high to overcome the frictional resistance of tubing and nozzles. The operating advantages gained with this fan include ease of maintenance, and economy of current.


Sheet steel ring attached to blade tips. Ring has radial vanes which form a centrifugal fan to supply small volume high-pressure hot air to defroster
Water connection
Inner fan delivers large volume low-pressure air through heating core



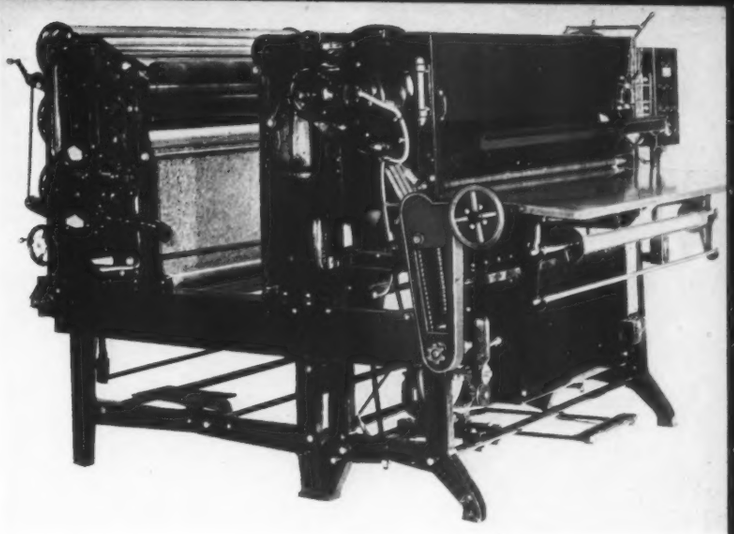
Group Two

MEDIUM SIZE MACHINERY

Textile machinery, bench drills and grinders, bottling and packaging machinery, air-conditioners, auto engines, compressors, hat machinery

115 companies reporting

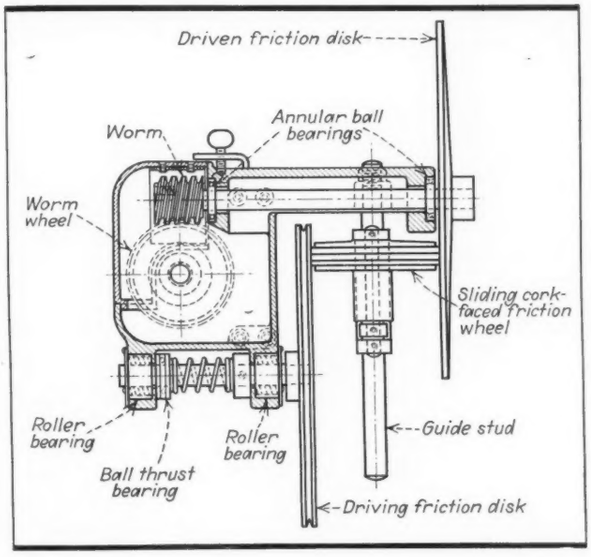
	Per Cent Using	Per Cent Increase
TYPES OF CONSTRUCTION		
Fusion welding	57	25
Flame cut parts	52	21
Resistance welding	38	14
Drop forgings	56	13
Sand Castings	92	12
Stampings	46	11
Die-castings	34	11
Molded plastics	37	7
DRIVES AND CONTROLS		
V-belts	77	38
Variable-speed drives	49	14
Motor speed reducers	42	14
Gears	72	12
Separate speed reducers	49	11
Magnetic controls	60	10
Chains	49	4
Flexible couplings	61	5
Mechanical clutches	46	4
Limit switches	45	6
Mercury switches	33	8
Automatic timers	23.5	5
Electrically operated valves	21	5
BEARINGS AND LUBRICATION		
Ball or roller	92	37
Grease gun fittings	72	16
Grease-sealed	59	15
Needle	43	12
Oil circulating pump	36.5	10
Oil filters	28.5	9
"Oilless"	46	8
Sleeve type	69	5
TYPES OF FASTENINGS		
Hollow head screws	70	24
Drive screws	37	7
Nut locking devices	56	5
Self-tapping screws	28	4
MATERIALS OF CONSTRUCTION		
Heat-treated alloy steel	80	23
Alloy cast iron	65	19
Stainless steel	59	12
Aluminum	69	11
Copper, brass, bronze	83	9
Low-alloy non-heat-treated steels	54	8
Monel	32	8
Zinc	18	7
Resilient motor mountings	25	6
Non-metallic gears	26	4
FINISHES		
Chromium plating	41	14
Organic coatings	62	8
Cadmium plating	42	6
Chemical coatings	15	3
Anodic coatings	10	3



COMBINING TWO UNITS, one for printing and other for developing and drying, this machine has all controls located on front of printing unit within easy reach of operator. Arc-lamp, thermostatic-control, and drive-motor switches are concentrated on dead-front panel box at right. Speed is controlled by handwheel at left. Strip-type heating element, built into feeding table, preconditions paper by removing excess humidity and thus prevents shrinkage during exposure.

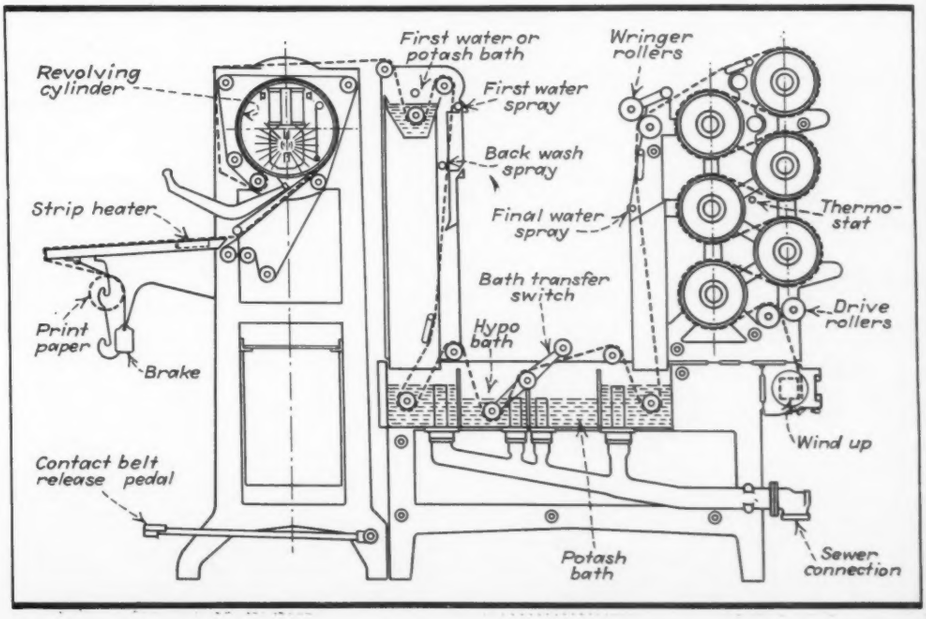
Coordinating Light, Heat and Speed for Automatic Blue-Printing

Revolving glass cylinder, thermostatic control and variable-speed friction-disk drive contribute to operating efficiency of Paragon-Revolute machine for continuous exposing, developing, and drying of sensitized paper

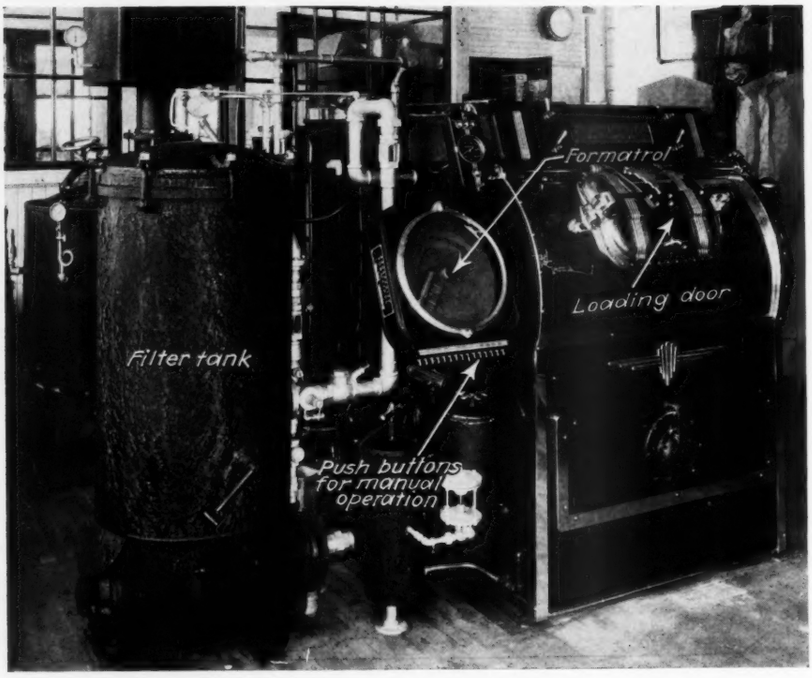


CROSS-SECTION OF MACHINE (below) reveals method of operation. Revolving Pyrex-glass cylinder carries paper almost entirely around arc lamp during exposure. Bath-transfer switch makes possible quick changeover from Hypo to Potash solution. Wringer rolls are soft, rubber-covered, "squeegee" type. Drying drums are made from 8-in-diam. aluminum tubes, $\frac{1}{8}$-in. thick, giving high thermal conductivity. They revolve on sealed ball bearings and are heated by six strip units connected in parallel and controlled by Minneapolis-Honeywell adjustable-temperature thermostat. Finishing-unit drive rollers operate from adjustable-tension slip clutch, driving member of which is connected by Diamond roller chains to variable-speed reduction unit.

VARIABLE-SPEED DRIVE (above) affords control of rate at which paper is exposed and finished. Handwheel, shown in top view, operates through rack-and-bellcrank linkage to move friction wheel up or down on guide stud, for faster or slower speeds respectively. Further reduction is by worm-and-wheel unit. Friction disks, one of which is V-belt driven from constant-speed motor, are polished steel and friction wheel is cork-faced for long life.

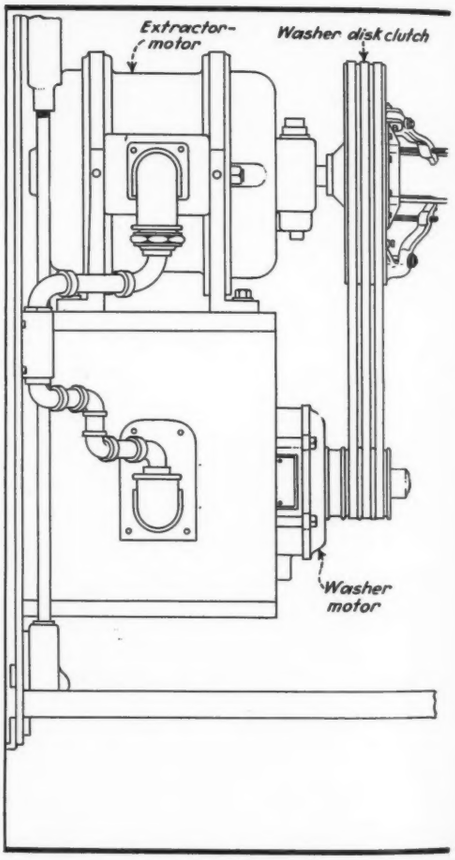


Air-Electric Interlocks and Cycle Controller Feature Prosperity's Dry Cleaning Machine



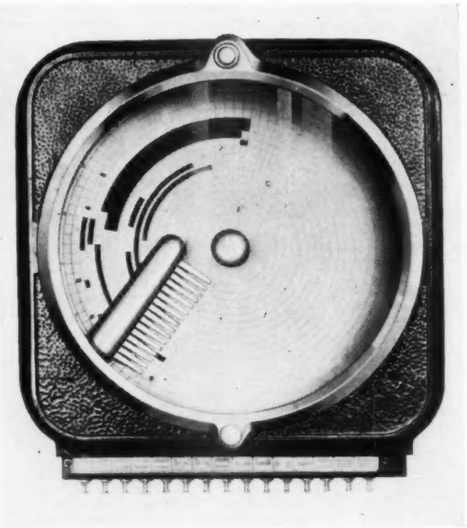
CYCLE OF OPERATION is fully automatic, successive operations being slow speed washing—the revolving cylinder reversing four times per minute—dirty solvent discharged through solenoid operated dump valve, rinsing, extracting at high speed, drying with temperature automatically controlled, deodorizing and automatic opening of the dump valve. Safety lock prevents opening the door when washer is running at high speed. All operations are controlled automatically by a Prosperity designed device called the Formatrol.

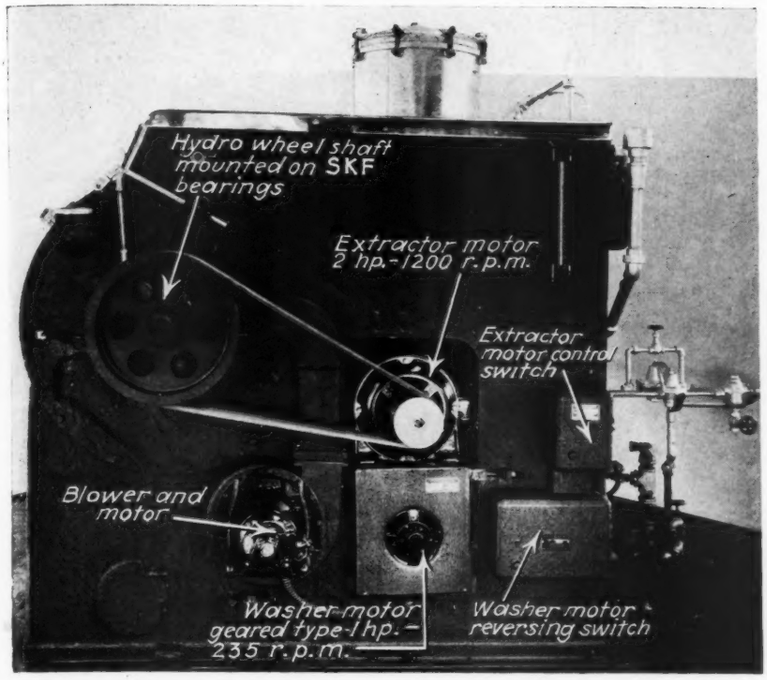
Design developed by Ernest Davis and Albert Kagi, chief and assistant chief engineer of The Prosperity Company. Housing is welded and hot-dip galvanized. Cabinet type construction puts into one housing many formerly separate units, reduces and simplifies piping. The new unit occupies only one-third the floor space.



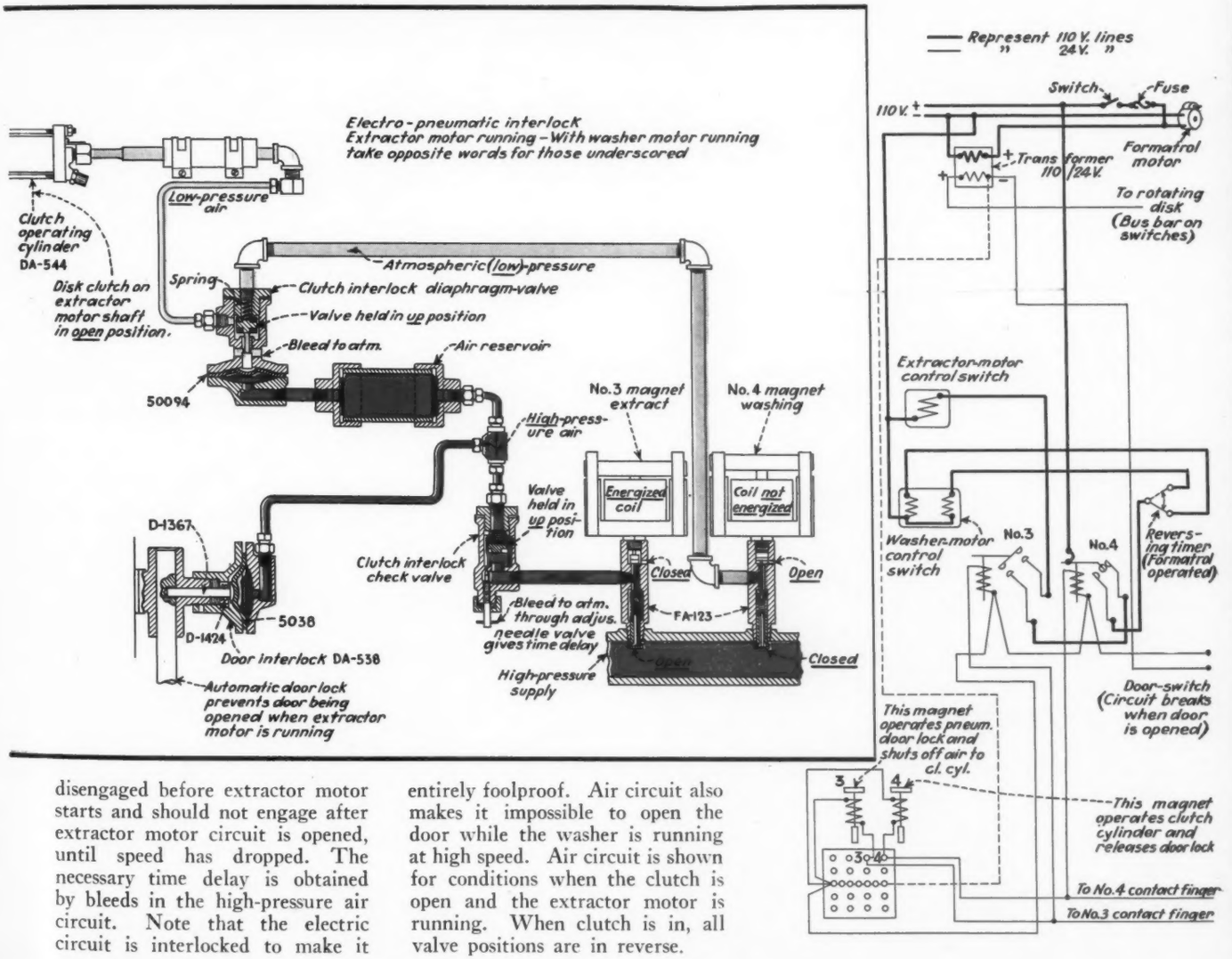
ELECTRIC CIRCUIT pneumatic circuit and air-operated clutch that engages and disengages the geared washer motor. Geared washer motor drives shaft of high-speed extractor motor on other end of which is V-belt drive to washer cylinder. Washer motor must be

THE FORMATROL is driven by a synchronous motor geared to give one revolution per hour to the cut paper disk. Sixteen contact fingers pressing on the paper disk make and break the pilot circuits of Dunco relays that control the motors and solenoid operated valves. An extension of the worm-shaft that drives the disk has a cam on it that makes the contacts for the pilot circuit of the washer motor reversing switch.




Hydro wheel shaft mounted on SKF bearings
Extractor motor 2 hp.-1200 r.p.m.
Extractor motor control switch
Blower and motor
Washer-motor geared type-1 hp.-235 r.p.m.
Washer-motor reversing switch

SIDE VIEW of the machine showing the arrangement of motors, switches and drives and one of the motor driven blowers for getting rid of the deodorant. The relays and solenoid operated valves are located in the lower part of the machine housing. Washer cylinder is welded perforated metal and its shaft is mounted on SKF bearings. The upper portion of the cabinet behind (to the right) of the washer cylinder is the storage tank for the clean solvent, a glass gage on the side indicating the level of the solvent. Entire absence of mechanical joints assures proof against leakage and the whole cabinet being hot-dip galvanized makes it corrosion resistant and gives double assurance against leakage.



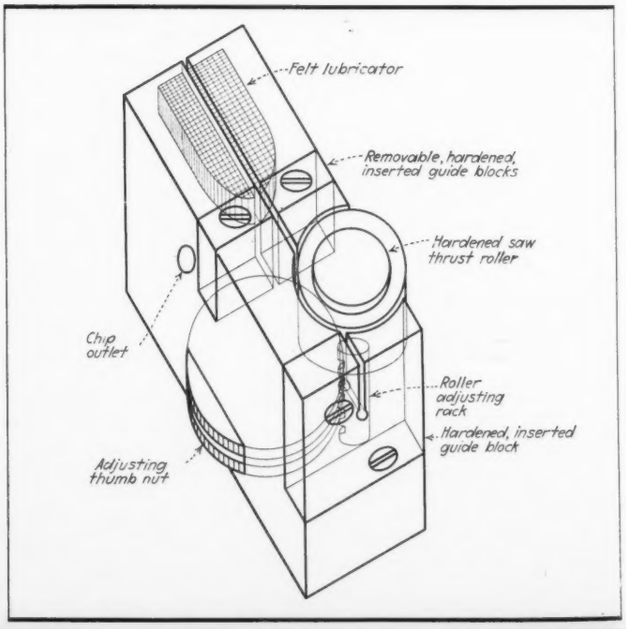
disengaged before extractor motor starts and should not engage after extractor motor circuit is opened, until speed has dropped. The necessary time delay is obtained by bleeds in the high-pressure air circuit. Note that the electric circuit is interlocked to make it entirely foolproof. Air circuit also makes it impossible to open the door while the washer is running at high speed. Air circuit is shown for conditions when the clutch is open and the extractor motor is running. When clutch is in, all valve positions are in reverse.

Continental's "Do-All"

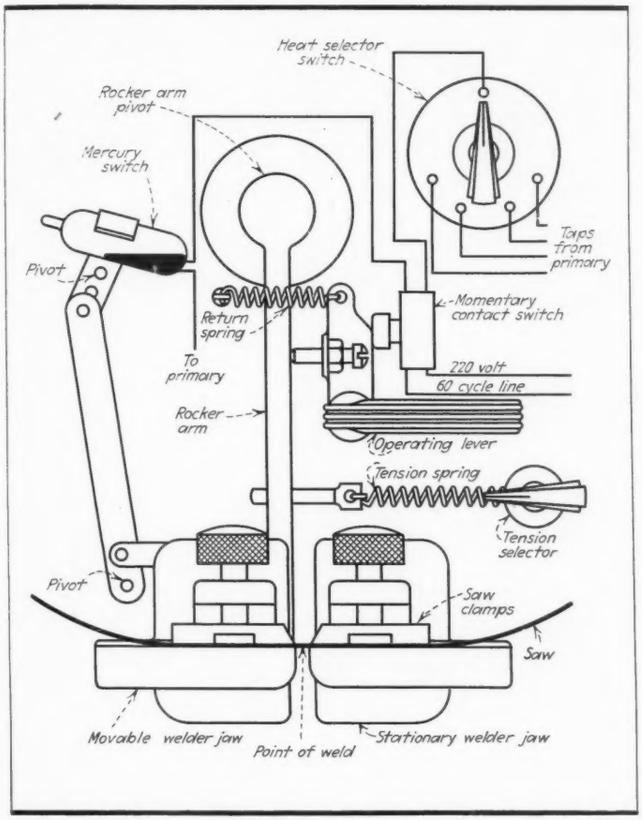
Efficient operation, economical structural design, and unified appearance-styling were the aims of Arthur E. Ringsrud, chief engineer of Continental Machine Specialties, in developing the Metalmaster for contour sawing or filing of thick steel, aluminum, brass or plastics

UNIT-ASSEMBLED DESIGN, besides contributing production-cost savings, permits styling that avoids appearance suggesting a modified band-saw for wood cutting and, instead, gives impressions of precision production, strength, and rigidity. Functional units include upper wheel with its mechanism for raising, lowering, or tilting the wheel; table, and mechanism for tilting table in four directions; variable-speed transmission; and welder for joining ends of band saw for internal cutting.

SAW WELDING UNIT, neatly assembled in column of machine automatically duplicates pre-selected conditions of heat and pressure. Unit is also used, with clamps set for wide gap, to anneal welded portions of blade to blue temper. Flash is removed by means of conveniently located grinding wheel shown.

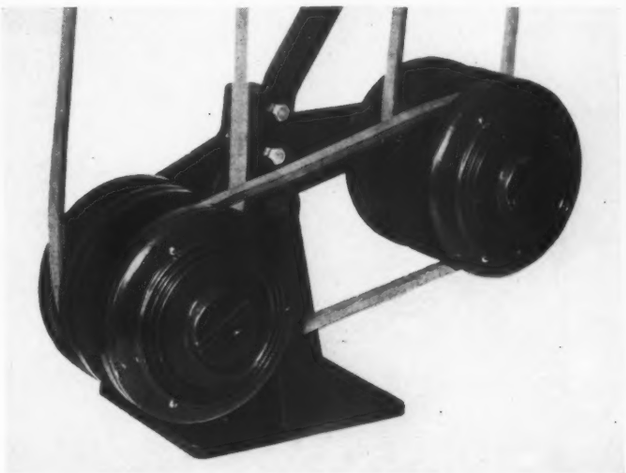


Engineered for Functions—Designed for Style

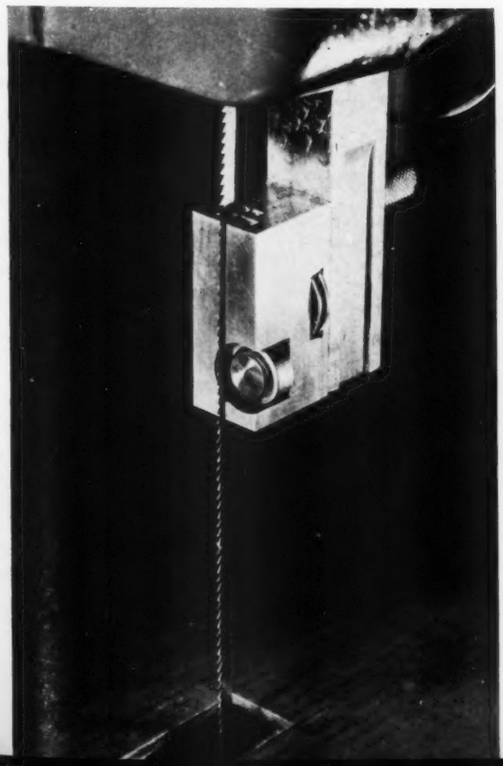


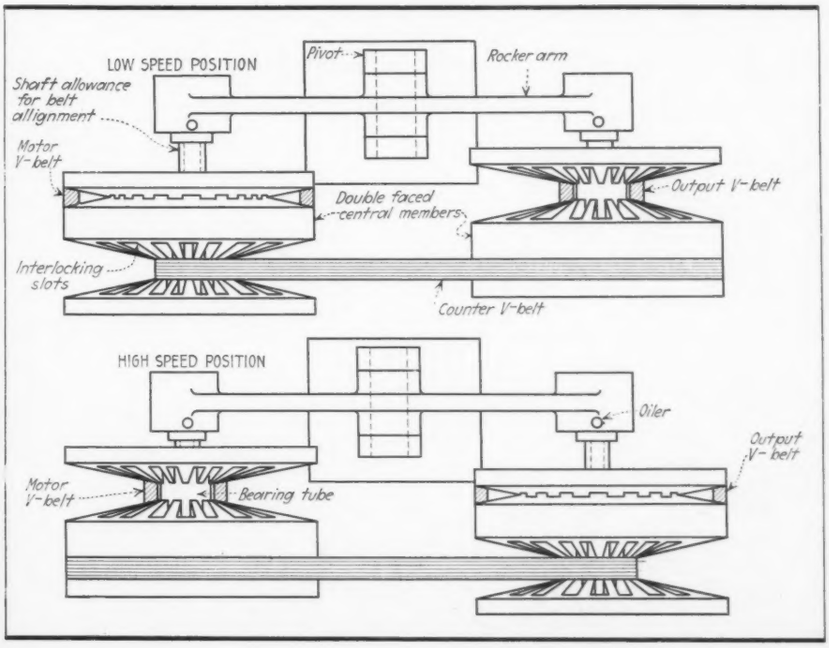
CONTROL OF WELDING TIME is by means of arrangement diagrammatically illustrated here. When saw ends have reached flowing heat, pre-selected spring tension causes movable welder jaw to move inward and tilt mercury switch, which breaks welding circuit. Momentary contact switch, besides initiating cycle, permits manual control of current flow when unit is used for annealing welded portions of blades.

VARIABLE-SPEED TRANSMISSION, giving a 16 to 1 speed range, consists of two double-grooved V-belt pulleys mounted on a centrally pivoted rocker arm. Slots in two outside faces of each pulley interlock with similar slots in double-faced central member that is free to move laterally between the outside members. Because of interlocking feature, central member is always in mesh with at least one outside face and therefore turns at same speed. Outside members are mounted on 6 in. diam. ground bearing tube.



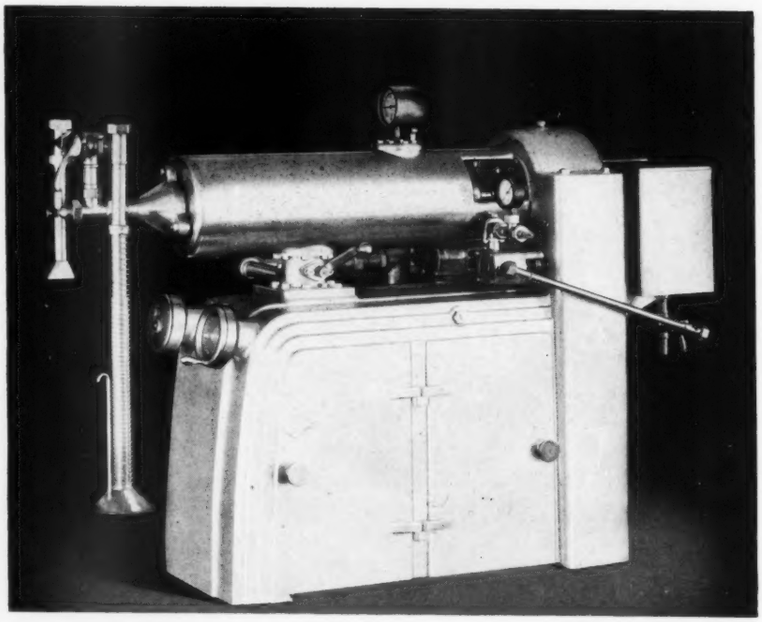
PRECISION SAW GUIDE has hardened guide-block inserts easily replaceable when worn. Hardened ball-bearing roller, which backs up saw, is adjustable to allow use of blades ranging from 1/16 in. to 3/8 in. in width. To left, below, on opposite page, is "phantom" view.



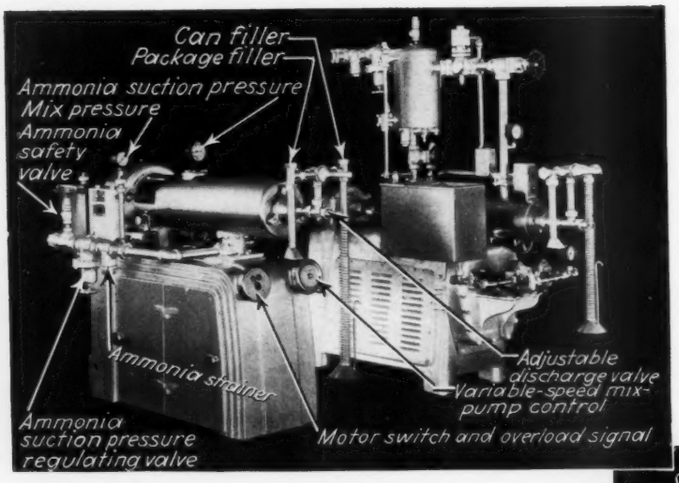


Simpler, Better Looking Freezer Results from Redesign

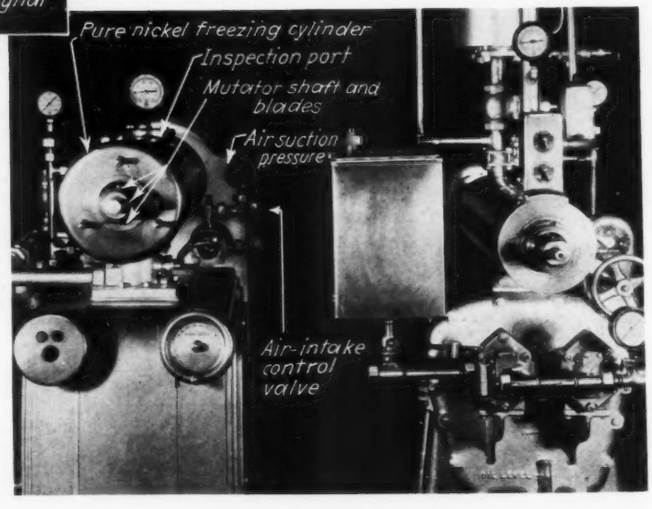
All ammonia equipment, except for suction line, is hidden away in base of new Commander model Vogt Instant Freezer for continuous production of ice cream. Sanitary seals and accessibility of all parts for cleaning are also interesting features of new design



CLEAN-CUT APPEARANCE distinguishes the Commander Vogt Instant Freezer. Controls and instruments are located with proper regard for operator convenience. Variable-speed control for ice-cream mix pumps is placed adjacent to can and package fillers, as also is motor switch with motor overload warning light. Doors are solid aluminum castings and are hinged for quick removal by lifting.

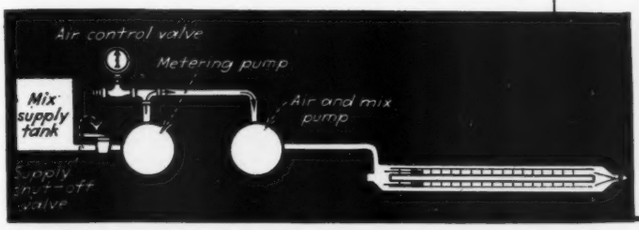


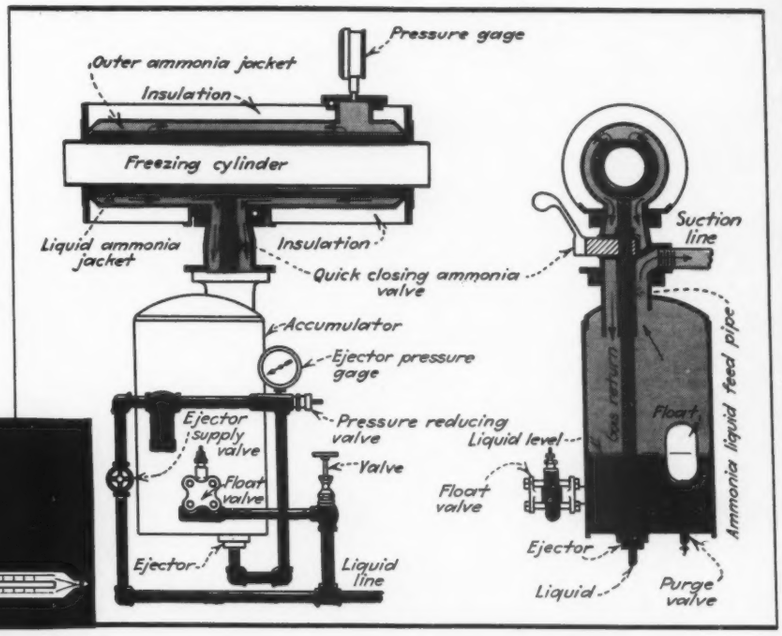
NOW IT'S ALL INSIDE. As shown at left, the ammonia system which in the Standard model was located above the freezer cylinder is now built into the base of the Commander model. With the new arangement, there is no overhead accumulator and piping to frost or sweat. Moreover, since the ammonia system is now below the freezer cylinder, improperly closed or leaky ammonia valves will not cause freezing up. In addition, piping has been simplified and the solenoid valve used on the Standard model is eliminated, the warning light being used instead. Less important functionally but more noticeable commercially is the improved appearance thus made possible.

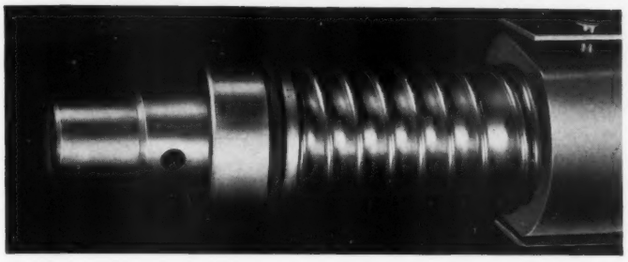


FREEZING CYLINDER of the Commander model has been increased in size as compared with that of the Standard model. Both, however, are made of pure nickel, and the clearance between the mutator shaft and cylinder remains the same, approximately 5/16 in. The Commander shaft, having been increased in diameter, is stronger and the scraper blades on it are also larger and stronger. Because of the restricted space between the shaft and the cylinder, the mix in the freezer is limited to only about 3 quarts, contributing to quick starting and the ability to freeze small batches. For the same reason, changes in flavor can be made with least intermixing and delay.

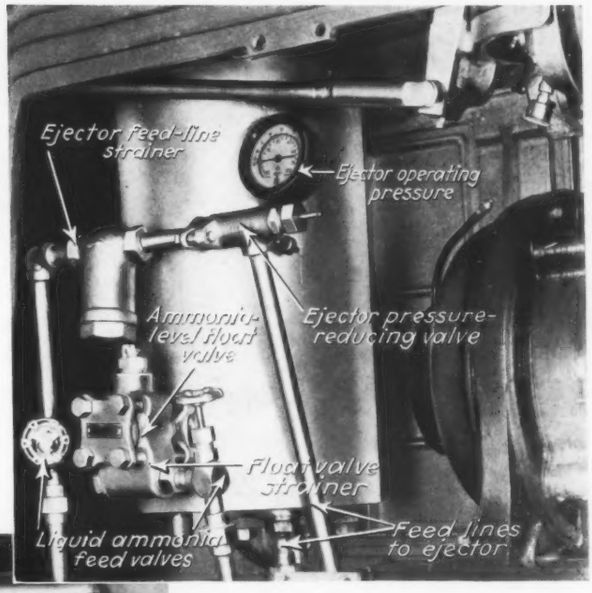
ICE-CREAM MIX flows from the supply tank to the metering pump which allows a measured quantity to pass on to the larger mix-and-air pump. Latter emulsifies mix and air and discharges into freezing cylinder which is kept at desired low temperature by ammonia system diagrammed at right.



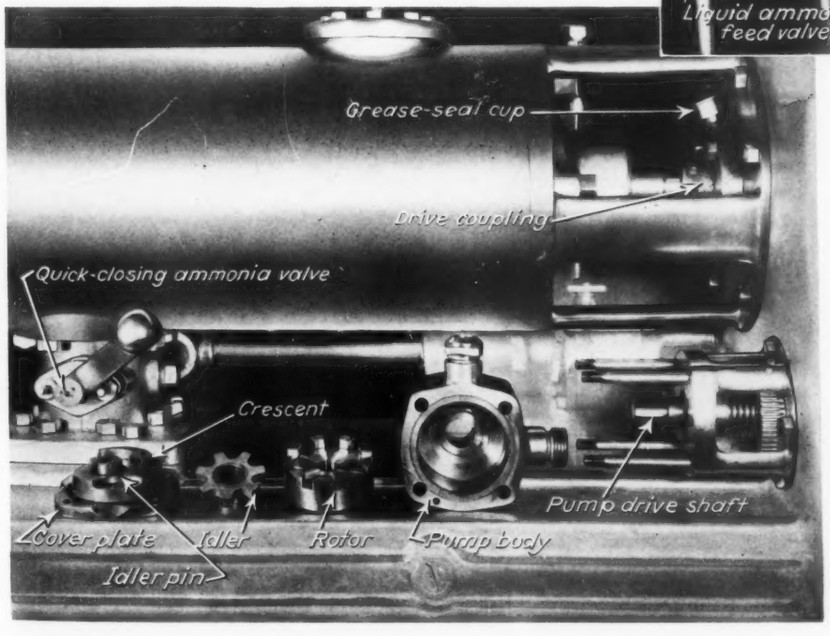




SANITARY ROTARY SEAL, used on drive end of mutator shaft, is here shown with parts spread slightly to reveal construction. Designed for sanitation and ease of removal.



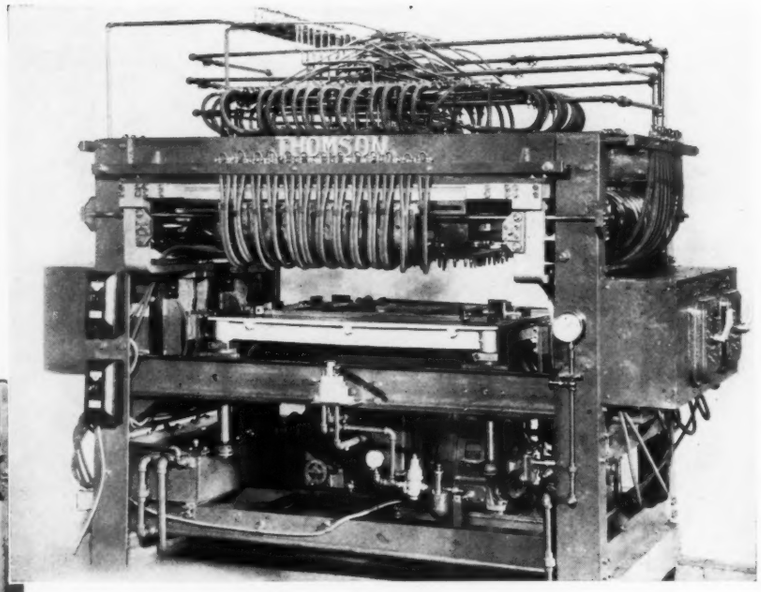
MIX-PUMP ASSEMBLY reveals simplicity of design and ease of removal for cleaning. In operation, action of idler teeth empties open rotor teeth, prevents jamming of material. Thrust bearing adjustment compensates for wear.

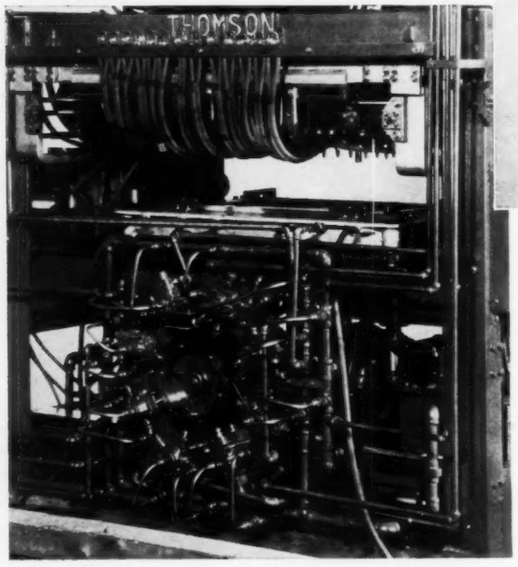


WITHIN THE BASE is the ammonia accumulator and its associated equipment, as well as the drive motor and a Reeves variable-speed drive for the mix pumps. Liquid ammonia, supplying most of the freezer's requirements, enters the accumulator through the float valve, as shown by diagram at top of page. Balance of ammonia bypasses the float valve, passing through strainer and pressure-reducing valve, while still a warm liquid, and thence through ejector nozzle where it expands and forces the liquid ammonia up the feed line and into the liquid-ammonia jacket.

Rotary Hydraulic Control Unit for Multiple Circuits

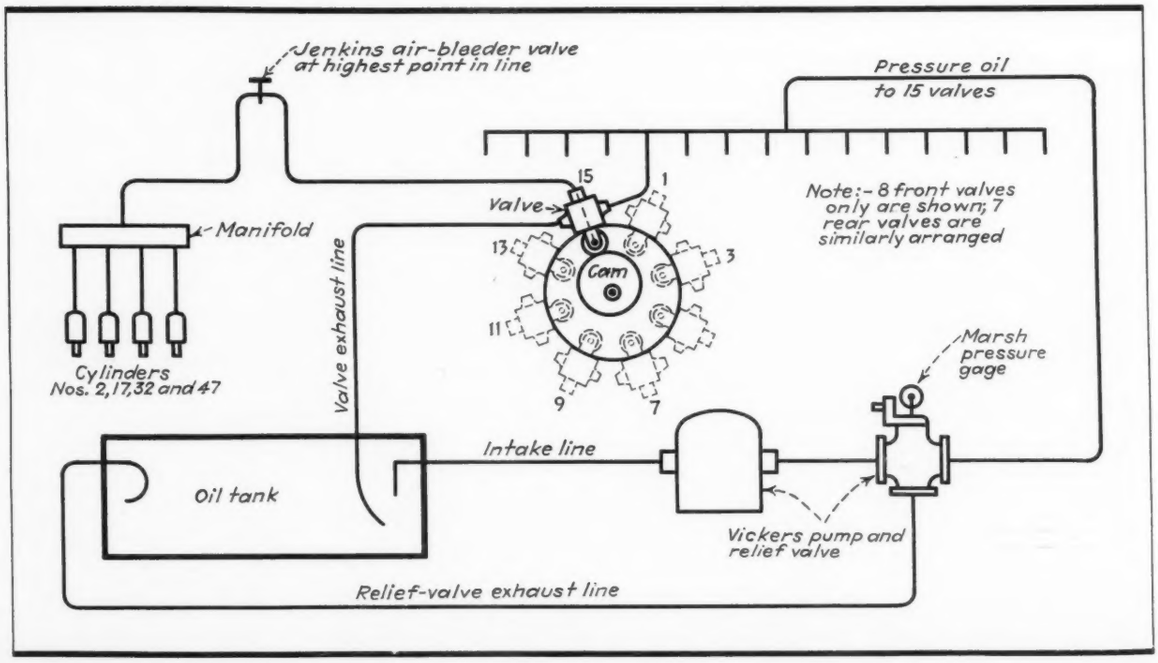
Thomson-Gibb "Multi-Spotmatic" machine is equipped with 60 cylinder-operated welding heads which can be so controlled and so located as to permit making welds rapidly at such locations and in such sequence as will eliminate distortion of the work. The key to its operation is the control unit



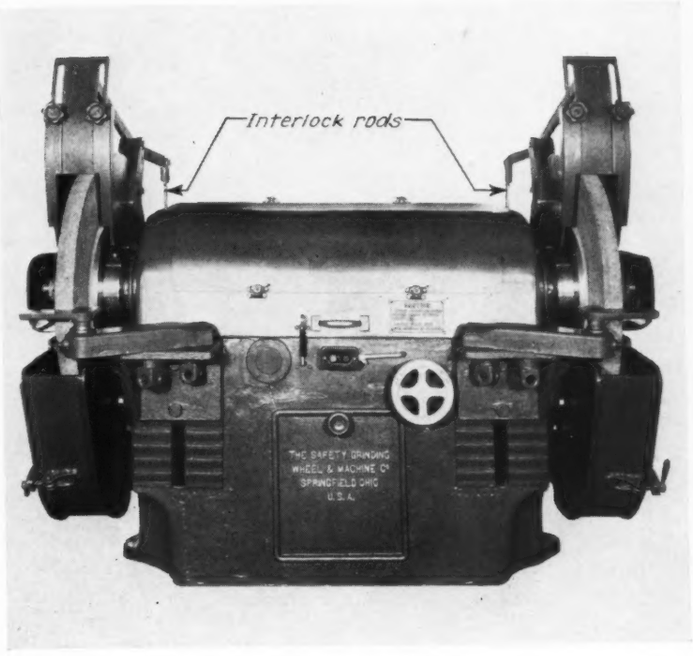


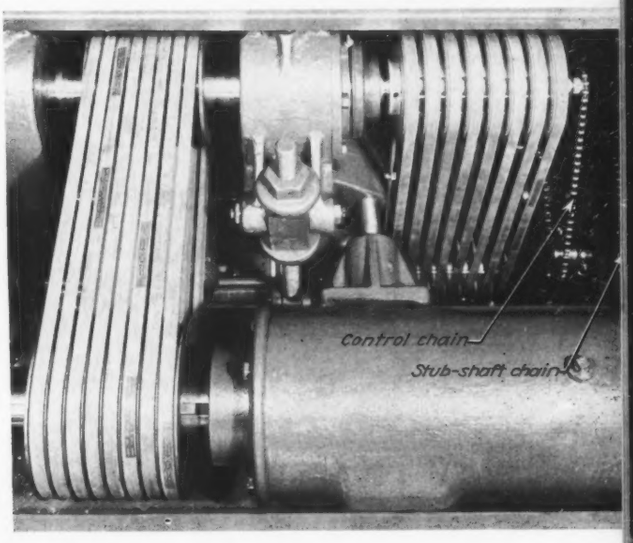
INTRICATE PIPING is required to connect the 60 welding heads to the control unit located at back of machine (left) but sacrifice in appearance is said to be more than offset by savings in construction and operating costs. Control unit is made up of 15 valves—8 at the front and 7 at the rear of the circular supporting frame. Cam operates valves and each valve controls 4 welding heads connected to 4 transformers mounted in pairs at each side of the machine.

SIMPLIFIED CIRCUIT shows how pressure oil is supplied through manifold to 4 welding heads as each valve is operated by cam. At same time, a limit switch fires the 4 transformers. Heads can be relocated for work on various assemblies by sliding them on rails and then locking them in place by means of set screws.



Interlocked Vari-Pitch Sheaves for Safety

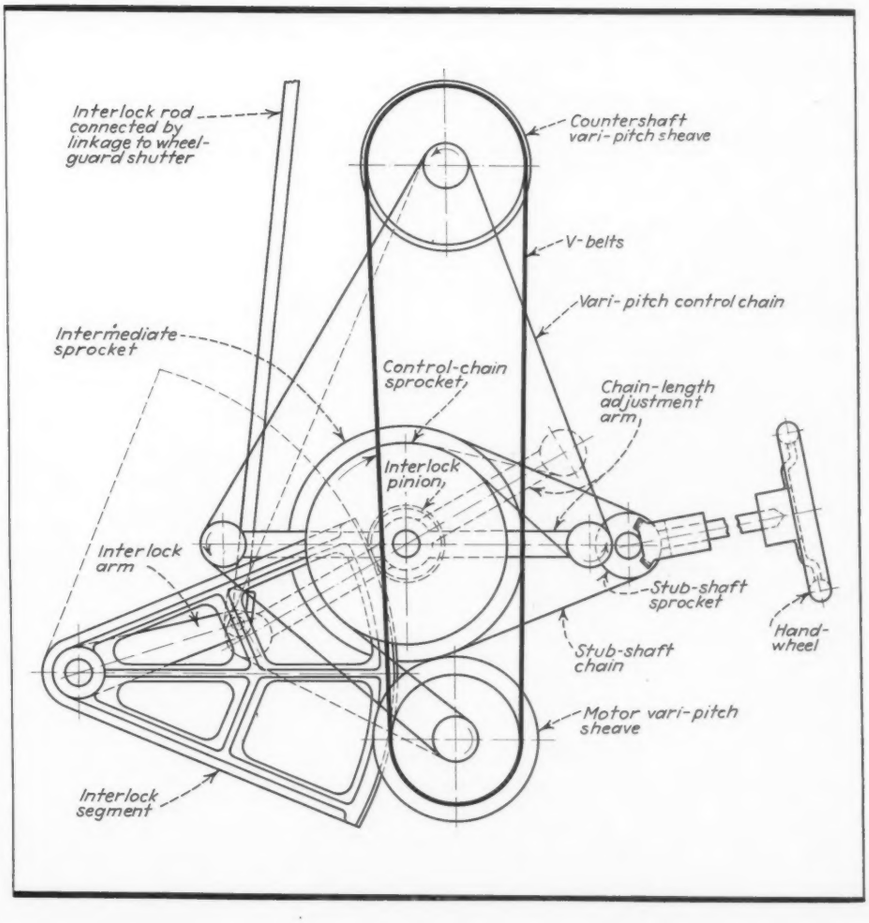




WHEEL SPEED is limited to either 6,000 or 9,500 surface ft. per min. by means of an interlock between the vari-pitch sheaves and the wheel-guard shutters. As wheels wear, spindle speed can be increased to maintain safe surface speed.

V-BELT DRIVE is through countershaft arranged for adjustment of both vertical and horizontal belts. Vari-pitch sheaves on motor and countershaft afford adjustment of spindle speed. Countershaft runs on heavy cartridge ball bearings.

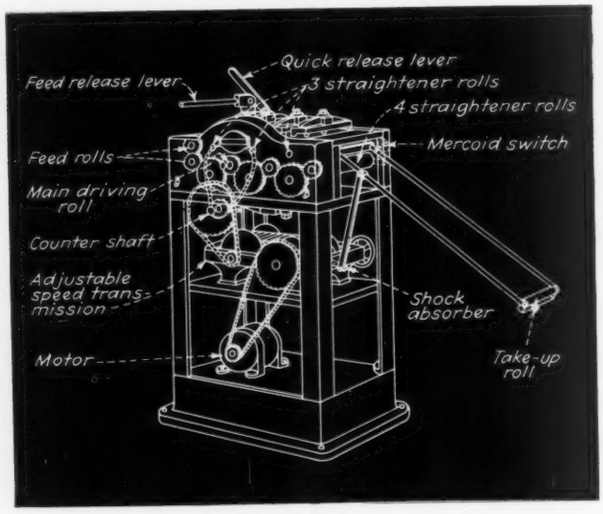
Approximately straight-line increase of wheel speed, within safe limit, is provided for by simple mechanical linkage used in new floor grinder built by Safety Grinding Wheel & Machine Company

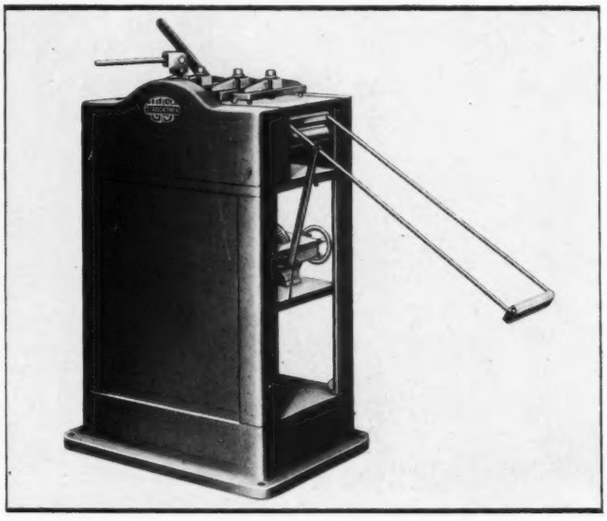


CONTROL CHAIN for the vari-pitch sheaves is operated by the handcrank through the stub-shaft, intermediate sprocket, and its own sprocket. Rigidly fastened to control-chain sprocket is an interlock pinion. This meshes with the interlock segment and causes interlock rod to close wheel-guard shutter when handcrank is turned to increase spindle speed. Shutter can be closed only as wheel wears; hence safe speed can be maintained but not exceeded. Adjustment arm for control chain, shown in two positions, permits adjustment to accommodate vertical belt stretch.

Take-Up Roll Tilts Switch Controlling Slack

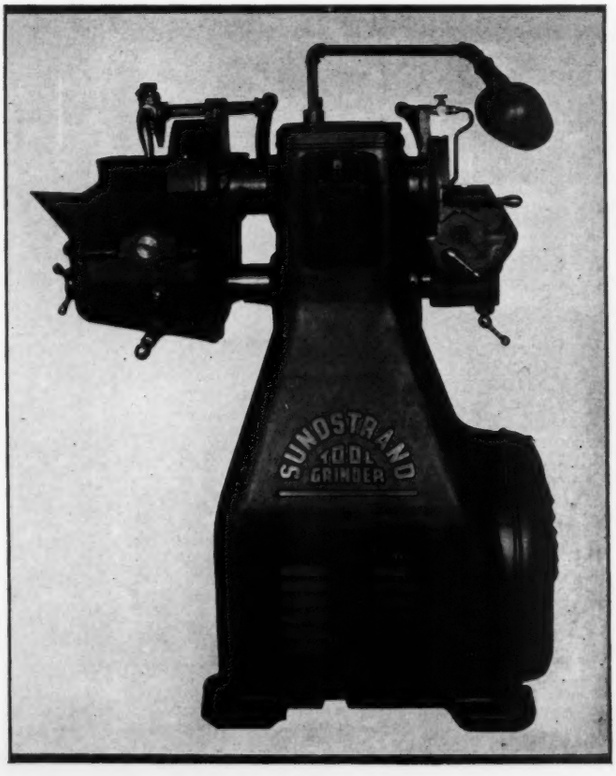
IN THIS TAKE-UP for U. S. power-driven straighteners the drive to the feed rolls is designed so that they will advance the strip stock at a speed slightly greater than that at which the press uses it. The loop of slack material supports the idler roller mounted on a swinging arm. As slack becomes excessive, idler drops, idler roller arm tilts mercury switch to cut off current to feed motor. As excessive slack is used up, roller moves up, tilts switch and restarts motor. All rollers are needle-bearing mounted, linkage holds all rollers parallel, new rolls can be inserted without disturbing settings, single movement of operating lever releases feed rolls to start new coils.

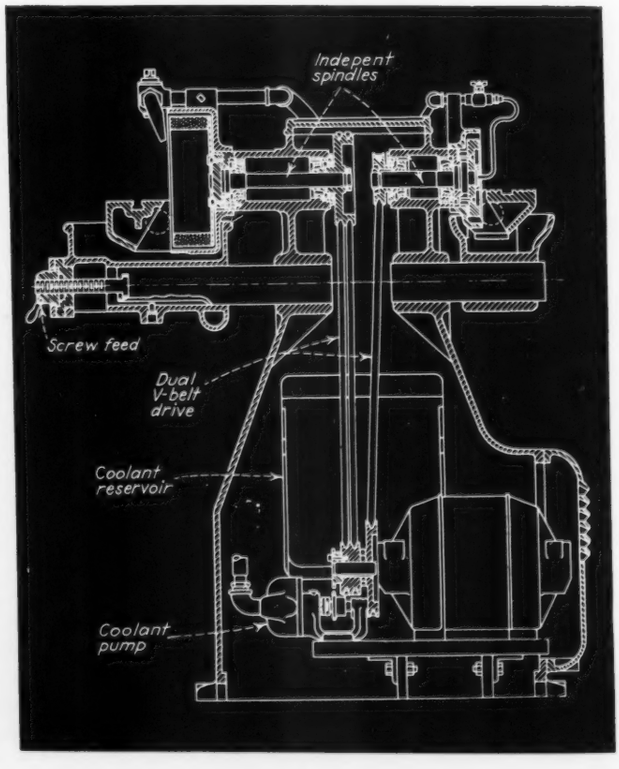




Dual Drive with Belts Running in Non-Parallel Planes

DIFFERENT SPEEDS were required for the two spindles of the Sundstrand double-end tool grinder. To get this result, a double two-diameter V-belt sheave on motor shaft drives with single belt to each spindle. Using V-belts permitted drive to be in non-parallel planes, made necessary because of spindle arrangement. Wheel spindles are heat-treated chrome-nickel steel running in grease-sealed roller bearings. Coolant from a removable 8-gal. reservoir mounted on rear of column is pumped to center of finishing wheel, spreading by centrifugal force in a thin film. Built-in swivel mounted lamp provides concentrated illumination where desired.





Group Three

HEAVY MACHINERY

Heavy presses, machine tools, paper and pulp mill machinery, mining and milling machinery, foundry molding machinery, diesel engines

72 companies reporting

	Per Cent Using	Per Cent Increase
TYPES OF CONSTRUCTION		
Fusion welding	43	24
Flame-cut parts	66	21
Sand castings	95	17
Resistance welding	36	13
Drop forgings	54	10
Roll formed sheet	16	6
Drawn sections	17	4
DRIVES AND CONTROLS		
V-belts	84	47
Magnetic controls	79	22
Variable-speed drives	45	14
Limit switches	61	14
Separate speed reducers	29	13
Hydraulic drives	42	11
Gear drives	70	10
Flexible couplings	42	7
Special motors	21	7
Electrically operated valves	35	7
Mercury switches	22	7
BEARINGS AND LUBRICATION		
Ball or roller	96	39
Oil circulating pump	70	22
Grease-sealed	60	21
Needle	61	17
Oil filters	54	9
Grease gun fittings	74	7
Unit bearing seals	42	7
TYPES OF FASTENINGS		
Hollow head screws	90	33
Nut locking devices	64	11
Drive screws	29	3
Self-tapping screws	20	3
MATERIALS OF CONSTRUCTION		
Heat-treated alloy steel	91	42
Alloy cast iron	80	36
Aluminum	49	10
Nitralloy	34	4
Hard facing materials	18	4
Plain carbon steel	81	3
Copper, brass, bronze	81	2
FINISHES		
Chromium plating	39	9
Organic coatings	54	6
Cadmium plating	22	4
Metal spraying	10	4

Hoe Full-Automatic Matrix Press

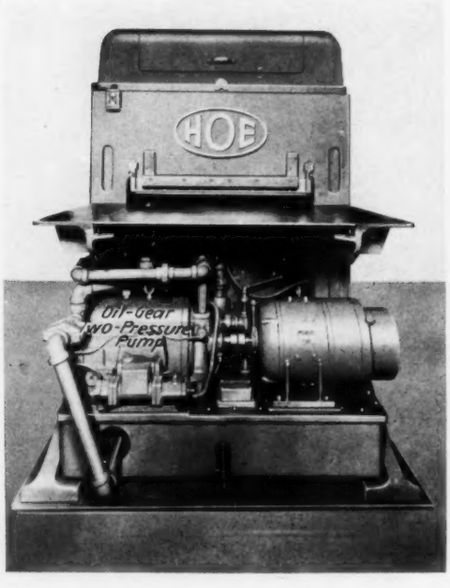
Pressure control, temperature control and timing for hot molding are full-automatic in this new 900-ton direct-acting self-contained bottom-ram hydraulic matrix press

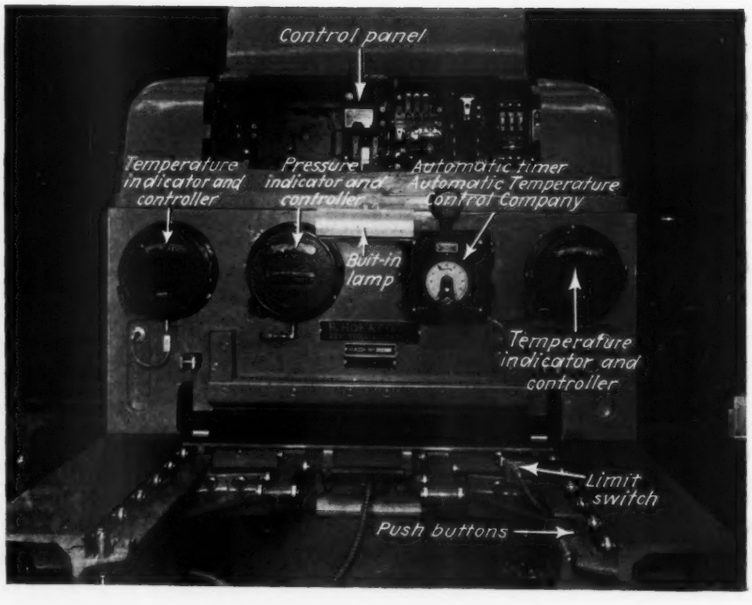
SIMPLICITY and complete safety of operation are the keynote of this Hoe matrix molding press. Main frame is a 5-ton steel casting with heavy ribs on outside. Sheet steel covering over ribs forms ducts between them, through which wiring and piping is carried. Ram is 26½ in. in diameter.

Combined temperature indicator and controller, Consolidated Ashcroft-Hancock make, one for upper and one for lower platen, hold temperature to desired figure within 10 deg. F. Automatic timer is set for desired duration of time that the matrix is to be held under pressure. Combined pressure indicator and controller is preset for maximum pressure and also for holding pressure.

Signal lamp over timer lights when the pressure is on, goes out when the pressure is released. Built-in lamp gives adequate illumination.

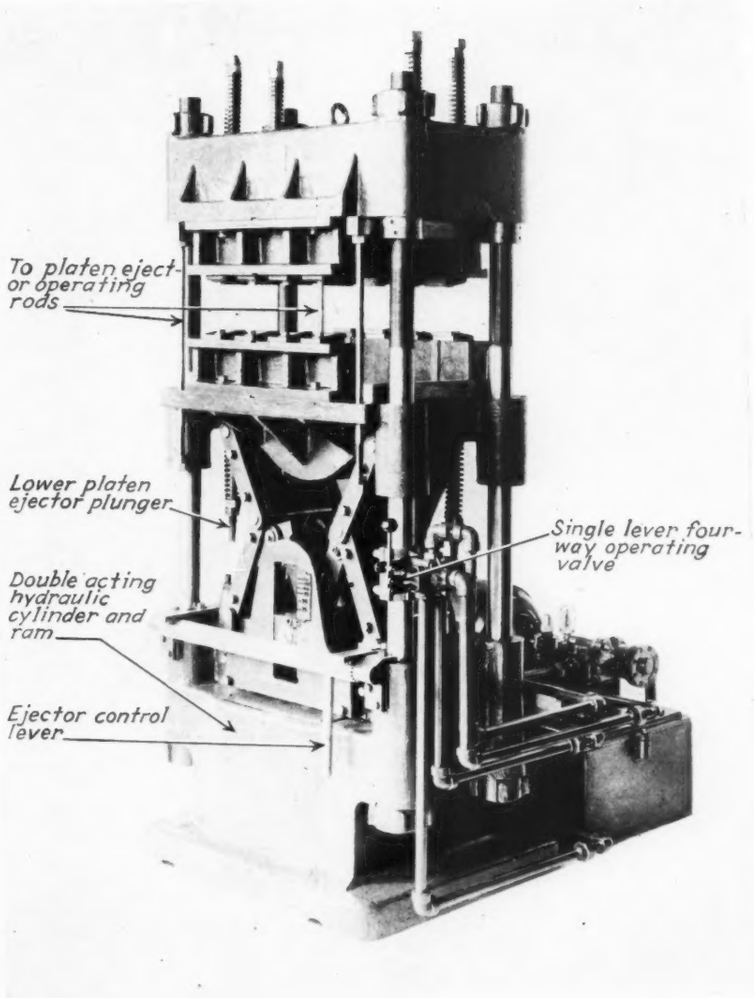
Pressing the push button starts the cycle, limit switches, pressure regulator and electric timer determine the operation of the G.E. Thrustor which actuates the hydraulic control valve. Oil-Gear hydraulic pump is direct driven, being connected to the motor by means of a flexible coupling.



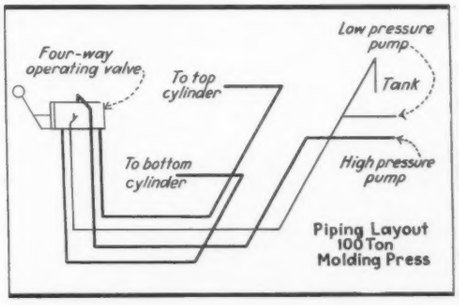


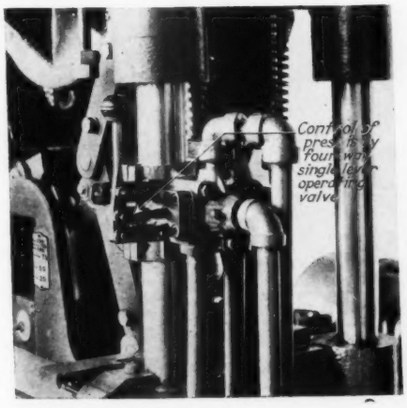
Hydraulic Molding Press with Toggles

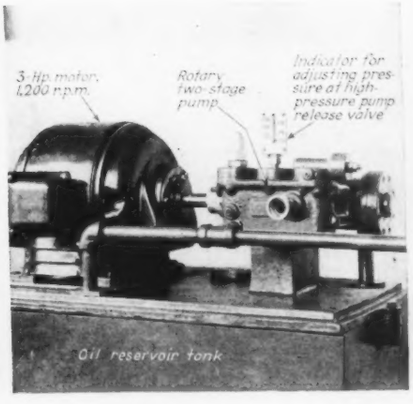
Adjustable thrust block in toggle for regulating force applied to press platen is a feature of plastic molding unit built by the Standard Machinery Company

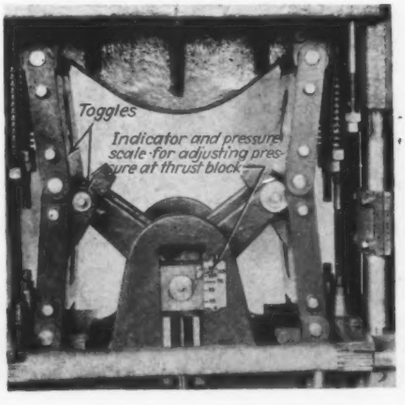

To platen ejector operating rods
Lower platen ejector plunger
Double acting hydraulic cylinder and ram
Ejector control lever
Single lever four-way operating valve

DOUBLE ACTING hydraulic ram eliminates pull-back cylinders. Ram exerts its force against adjustable thrust block in toggle linkage connected to lower press platen and to press frame for the fixed abutment. Maximum unit hydraulic pressure acting on the ram can be set by relief valve adjustment at combination high and low pressure Vickers pump. Low pressure pump automatically cuts out a predetermined pressure and high pressure pump continues to build up pressure. Large volume low pressure discharge from pump closes press at a maximum speed of 45 in. per min. The pressing speed of platen decreases as the toggles straighten from 5.7 in. per min. to standstill. Opening the press is accomplished by admitting pressure to top side of cylinder and releasing the bottom side, opening speed is 60 in. per min. Complete control of press movements is effected with one four-way lever operated valve.



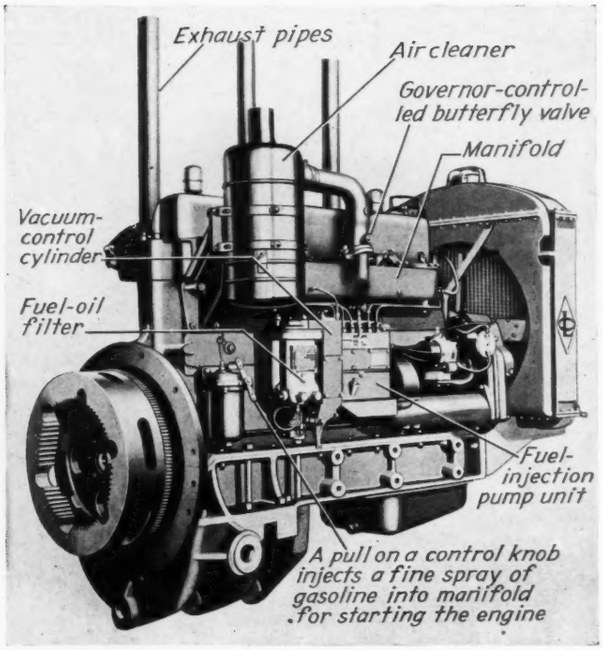



3-Hp. motor, 1,200 r.p.m.
Rotary two-stage pump
Indicator for adjusting pressure at high-pressure pump release valve
Oil reservoir tank

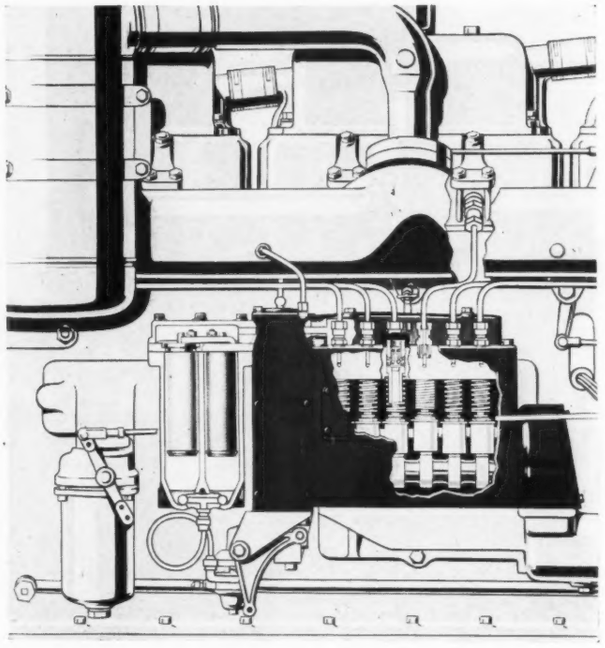


Controlled Ignition Allis-Chalmers Oil Engines

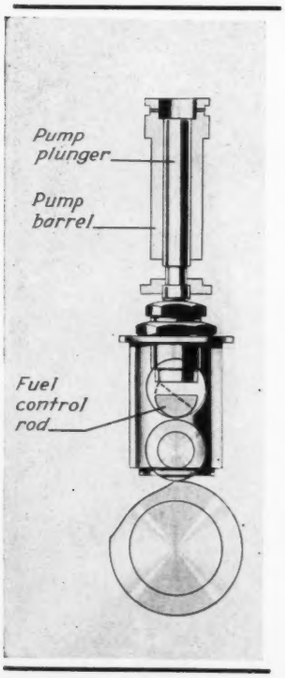
Diesel-fuel-burning engines with spark ignition have individual fuel injection pump units for each cylinder. These units are inclosed in one pump housing. A balanced air-fuel ratio is automatically maintained for every load and speed

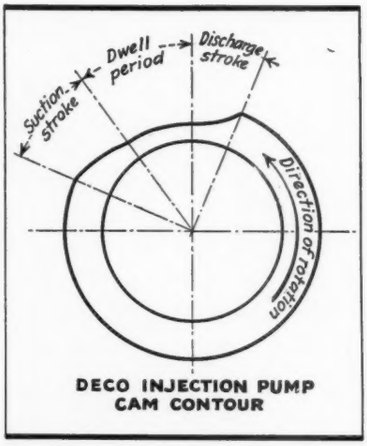

Exhaust pipes
Air cleaner
Governor-controlled butterfly valve
Manifold
Vacuum-control cylinder
Fuel-oil filter
Fuel-injection pump unit
A pull on a control knob injects a fine spray of gasoline into manifold for starting the engine

WHEN STARTING THE ENGINE, gasoline is sprayed into the intake air manifold and as engine turns over the fuel pump starts injecting the correct amount of fuel into each cylinder in the proper firing order.



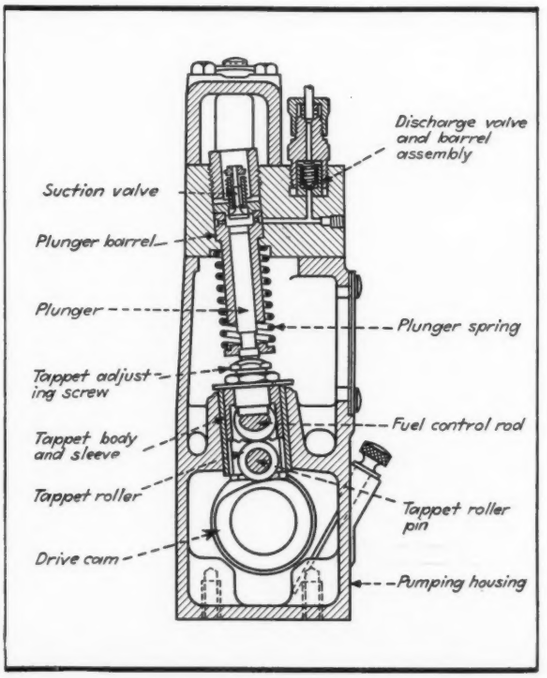
ECCENTRIC DRIVEN diaphragm type transfer pump with built-in screen draws oil from fuel tank, builds up pressure to approximately 10 lb. per sq. in. and forces fuel through filter into injection pump suction manifold fuel reservoir.



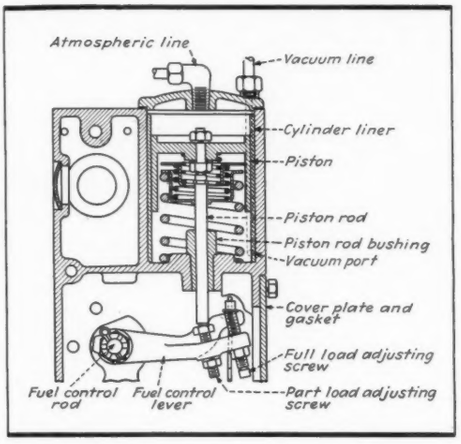


DECO INJECTION PUMP CAM CONTOUR

INJECTION PUMP unit, tappet body, actuating cam and pump assembly. The fuel control rod is rotated by linkage connected to a vacuum control cylinder and piston. In dotted position, fuel control rod raises tappet assembly, decreasing the plunger pumping stroke.

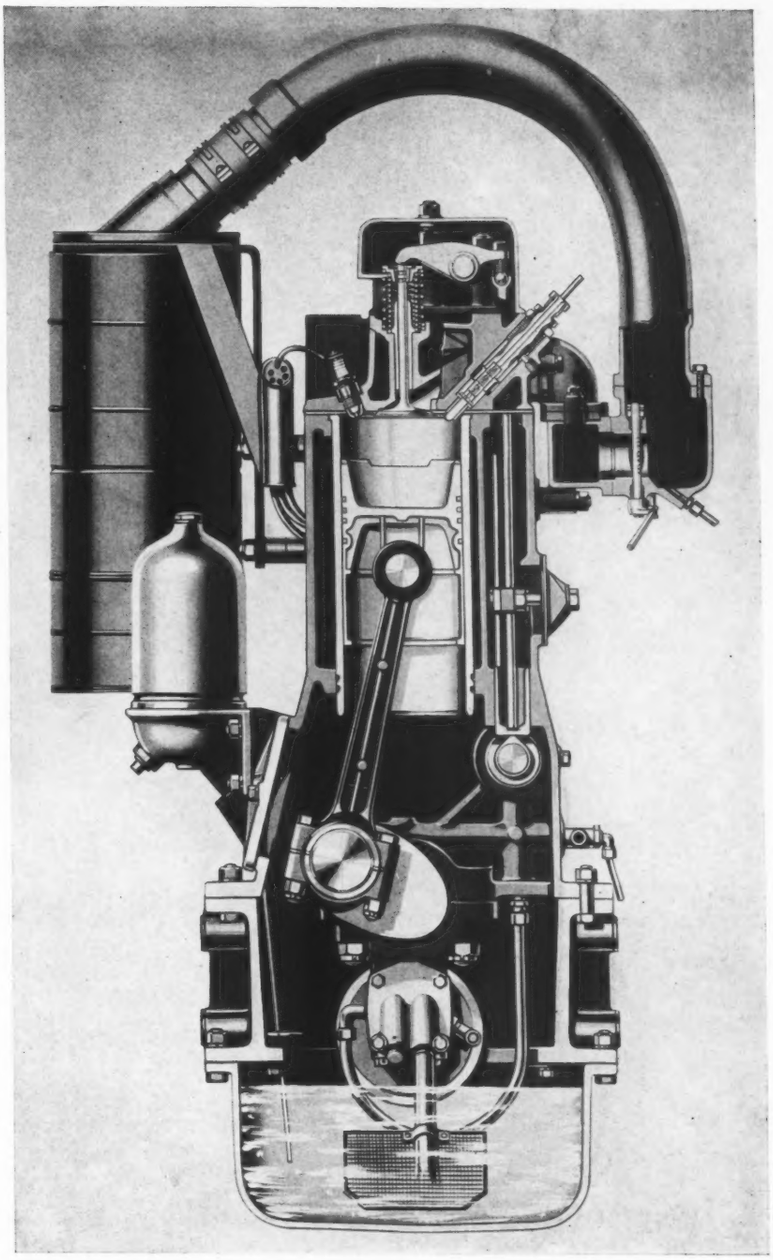


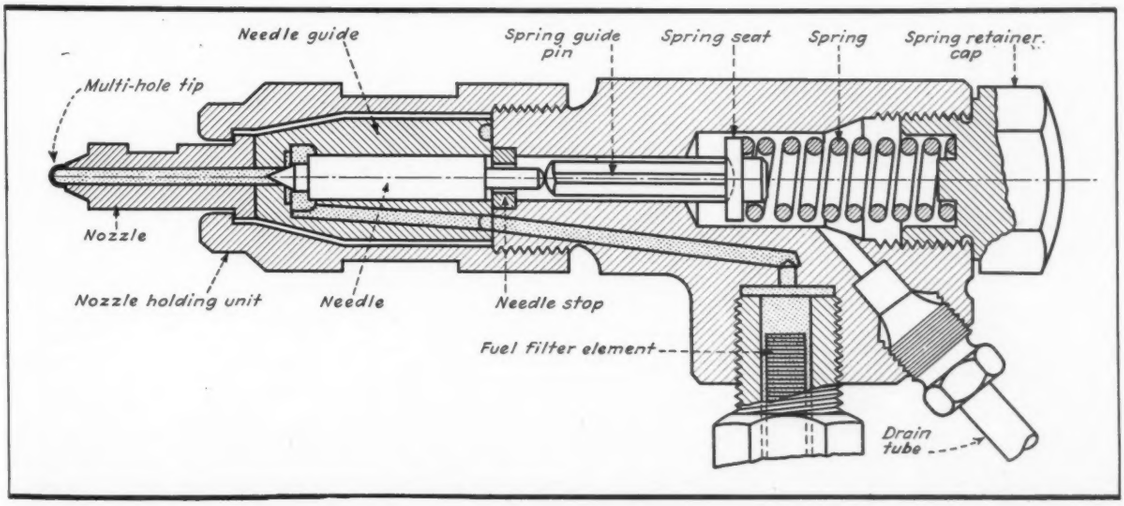
VACUUM CONTROL PISTON chamber is connected to atmosphere, the space under piston is connected to suction manifold where vacuum pressure changes with speed of engine causing piston to move up or down. Motion of piston rod is transferred to fuel control lever which positions fuel control rod in accordance with changes in manifold vacuum and load on engine and thus controls the quantity of fuel injected into the cylinder combustion chamber.

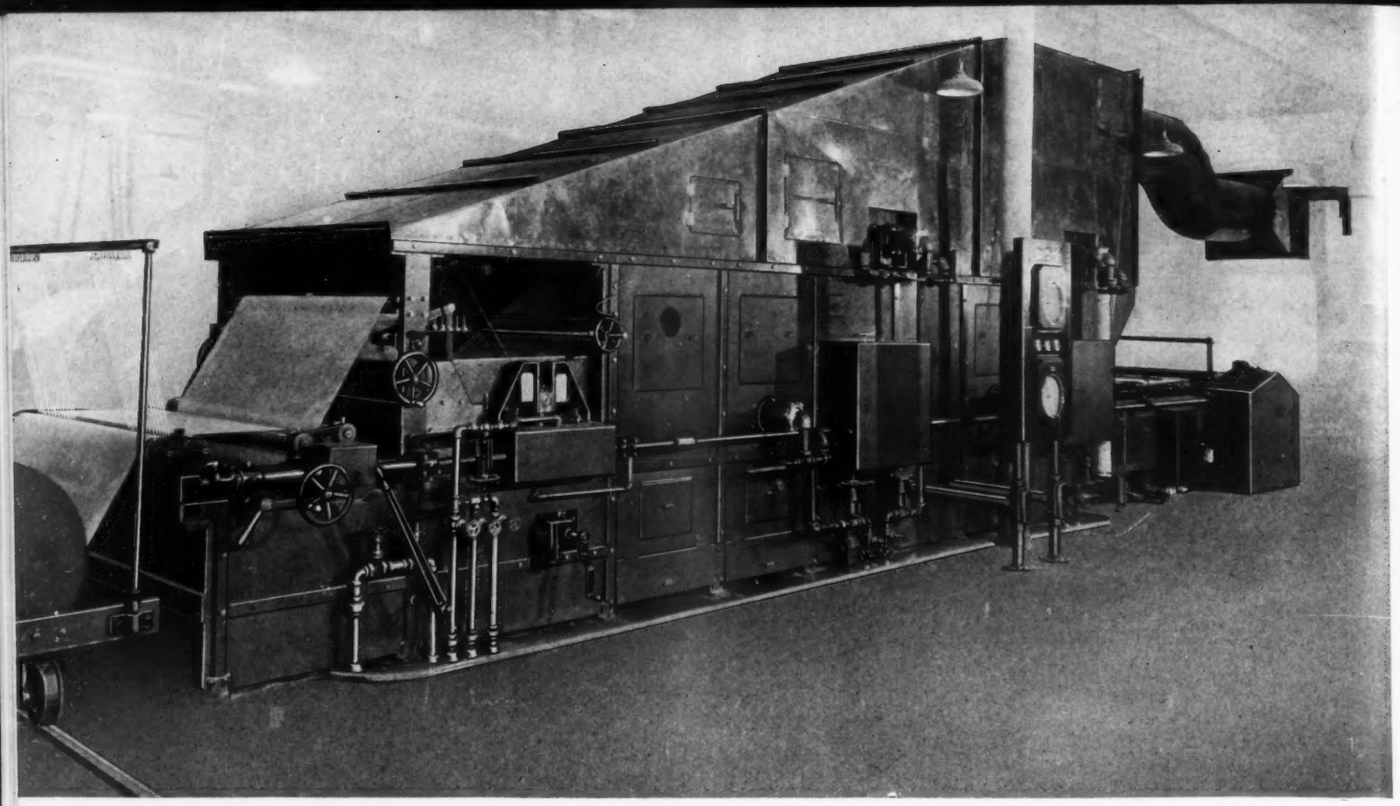


ENGINE BLOCK cross-section through cylinder injector. Removable cylinder liners are used in order to eliminate costly reboring. Exhaust valve seats are of tungsten steel, Stellited and shrunk in. One cylinder head covers two cylinders.

FUEL OIL under about 1,300 lb. per sq. in. pressure is delivered by the injection pump to the injector, thereby opening the needle valve against spring pressure thus releasing and injecting the fuel into the combustion chamber. The nozzle has 9 capillary-bore holes. All working parts of the injector assembly are away from the heat of the combustion chamber.

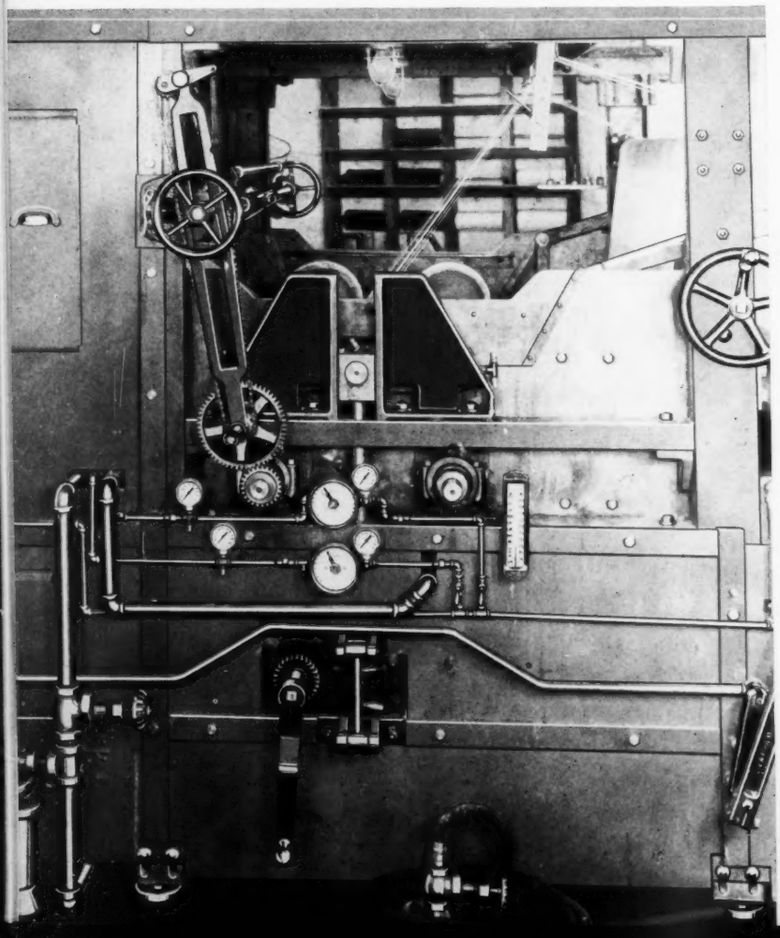






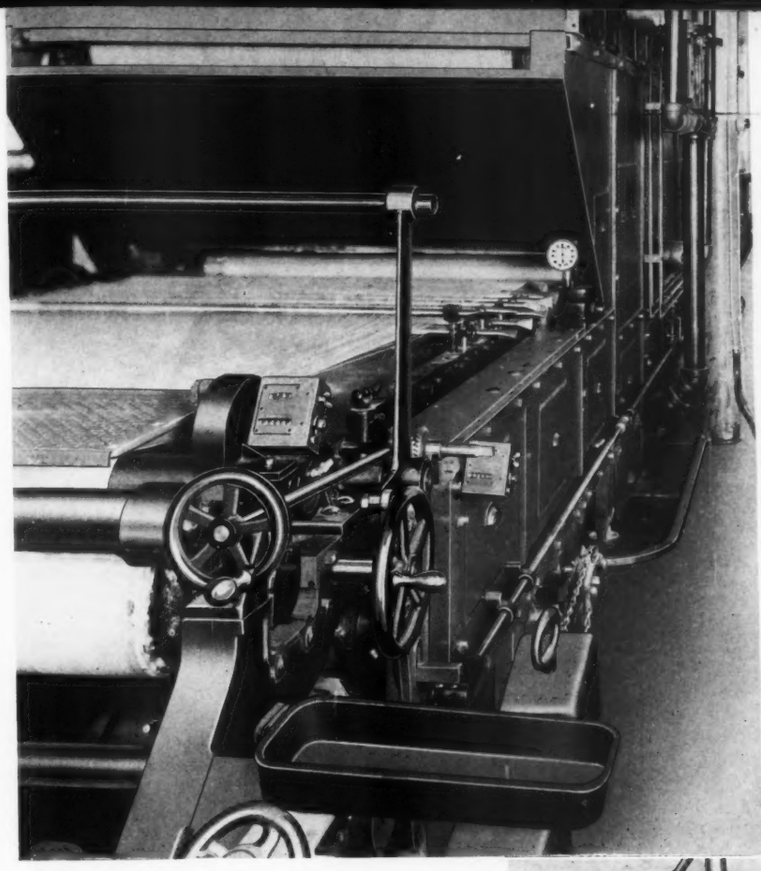
Six Correlated Assemblies in Saco-Lowell Textile Machine

Complete automatic control and anti-friction bearings make possible speeds of 90 yds. per min. in machine that prepares warp for 108-in. sheetings



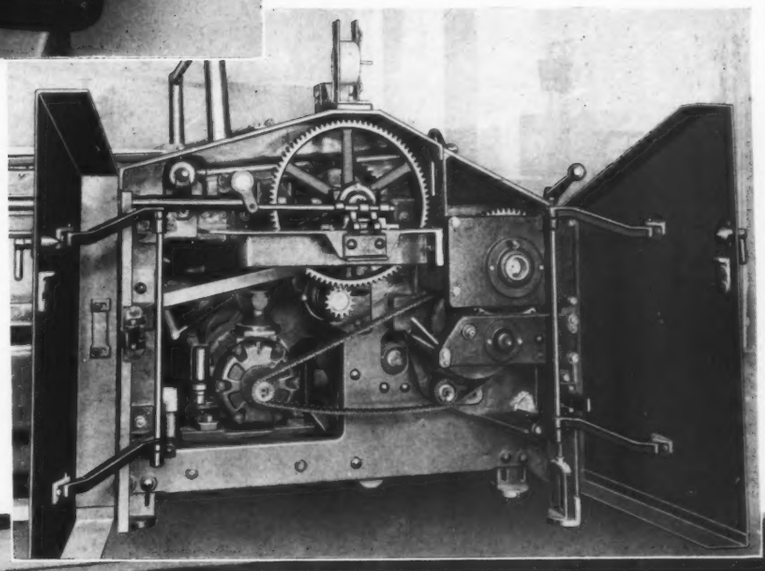
MADE UP OF SEVERAL UNITS, this system cooks, stores, and circulates the size; sizes, dries and beams the warp; controls the temperature and movements of the size; also controls admission of steam and discharge of condensate. Frame is built of structural steel reinforced and braced to carry cylinders without vibration. There are four 5 ft. diam. cylinders arranged for differential drying. Shafting is supported in anti-friction bearings with provision made for high-pressure lubrication. Cylinders are positively driven and are supplemented with Saco-Lowell automatic release gears. This device prevents any deterioration in weaving qualities of the yarn which might result from excessive tension and stretch. The instant that the tension in the yarn exceeds the predetermined amount the gears release automatically, and the cylinders run free until the tension on the yarn is decreased to normal. A uniform stretch that does not exceed 1½ per cent is maintained with these gears. Steam and condensate are handled through special joints that eliminate stuffing boxes and glands.

SQUEEZE ROLLS are a distinct departure from conventional designs formerly used. They are carried in anti-friction bearings supported by a framework supported in a crosshead which slides in gibs provided at each side of the size box. By means of a handwheel these crossheads and the supported framework can be raised so that the position of each squeeze roll can be reversed at will. The pressure on the roll can be increased by using a lever and weight as an auxiliary source of pressure. Size box is equipped with the necessary handwheels to raise and lower the immersion roll and to turn the squeeze rolls which are covered with a worsted yarn applied by the McGann system. Necessary gages and control valves are provided to maintain proper temperature and circulation of the size.

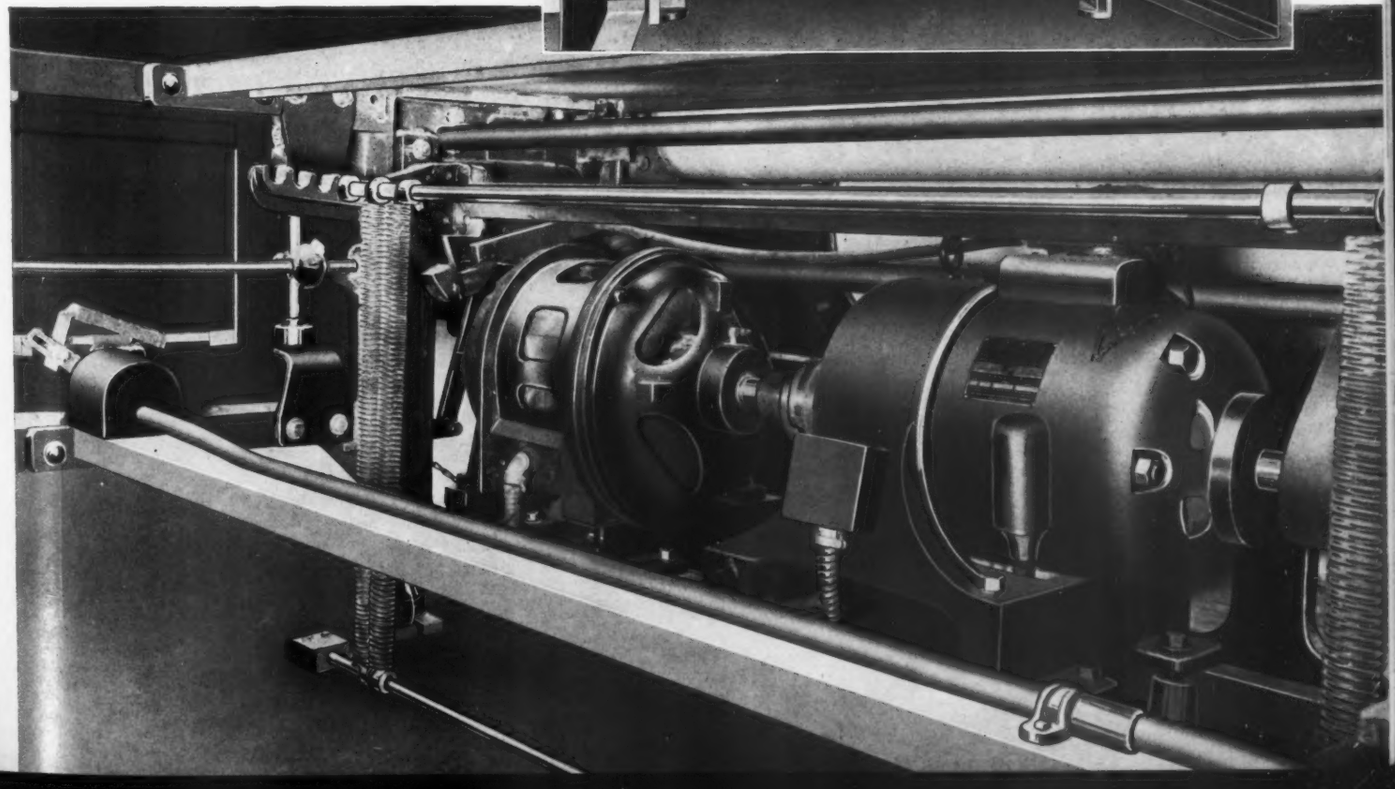


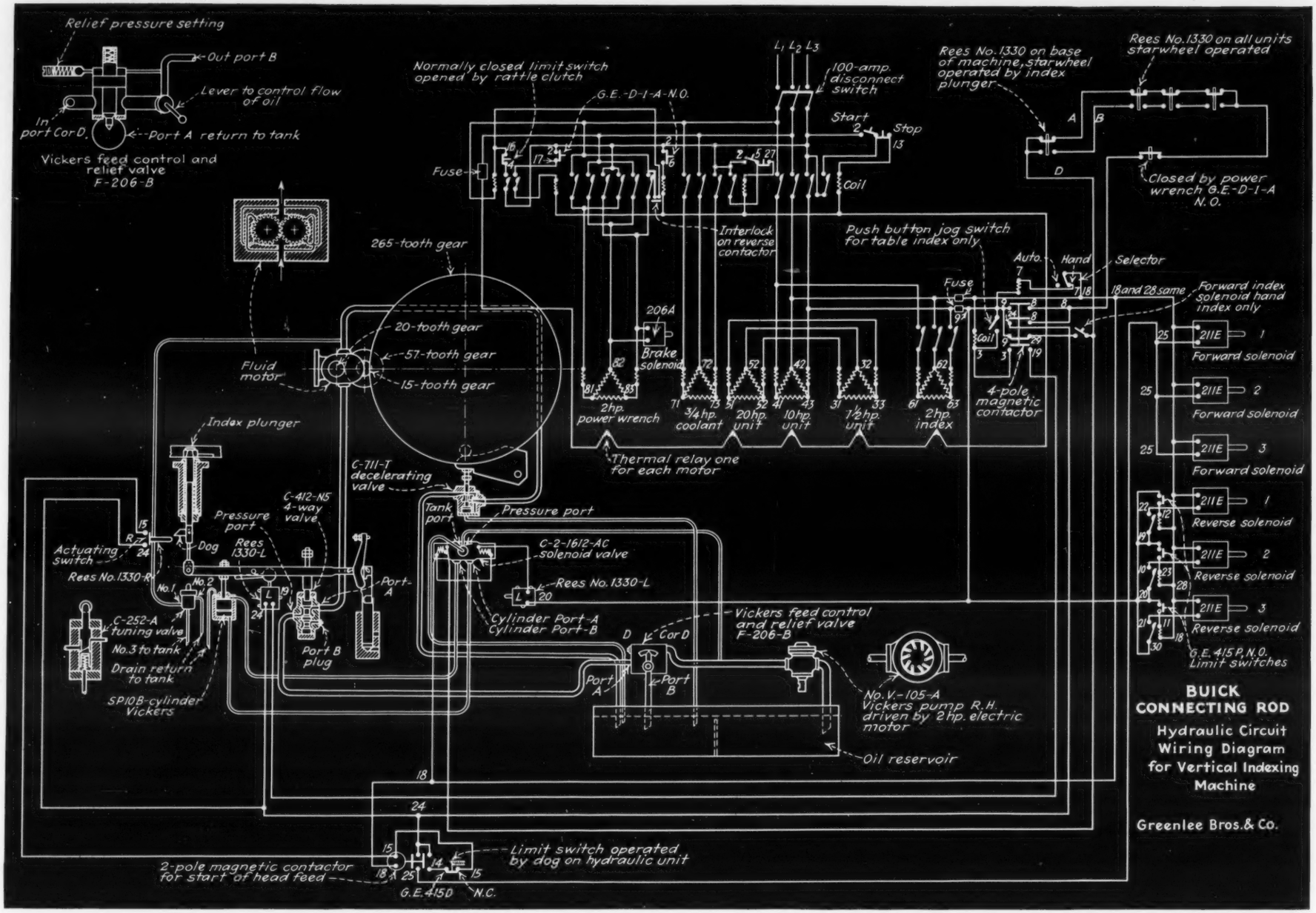
HEAD END of the high-speed slasher is equipped with traversing press roll, ball bearing trucks, a safety guard at the drag roller, and a convenient stopping and starting handle which is supplemented by push-button control stations. The head end also carries a meter to record the yardage delivered by the drag roller, the yardage of the yarn delivered at the size box, and a tachometer to show the speed of the slasher in yards per minute. The usual handwheels for controlling the position and spread of the comb and contractor mechanism are also provided. The head end also carries a high-speed fan driven by an independent motor to circulate the air under the slasher to cool the yarn before winding it on the beam. This motor is interlocked with the driving motor, so that when the slasher is put on slow speed, the fan is stopped. The slasher has no friction nor speed cone drives, changes of speed are accomplished by variable-speed Transitorqs.

DRIVING GEARS at the head end are all inclosed within a steel casing with quick-opening doors. On this casing is mounted a handle which controls a clutch to throw out the speed change mechanism when starting the work.



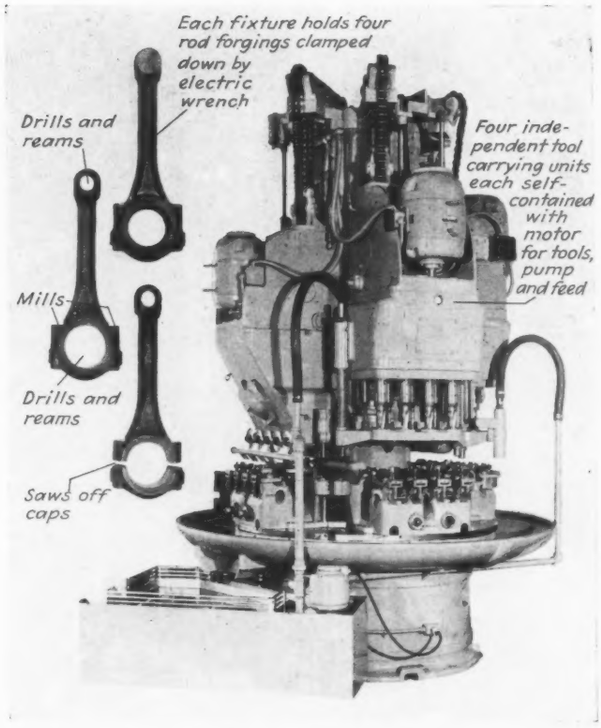
POWER AND WINDING-ON ASSEMBLY is built into head end, and consists of two-speed motor, automatic switches and two New Departure variable-speed Transitorqs. When machine is stopped the Transitorq automatically shifts back to the low-speed high-torque position.




Relief pressure setting
Out port B
Lever to control flow of oil
In port Cor D.
Port A return to tank
Vickers feed control and relief valve F-206-B
Normally closed limit switch opened by rattle clutch
G.E.-D-1-A-N.O.
L1 L2 L3
100-amp. disconnect switch
Start
Stop
Fuse
Coil
Interlock on reverse contactor
Rees No. 1330 on base of machine, starwheel operated by index plunger
Rees No. 1330 on all units starwheel operated
Closed by power wrench G.E.-D-1-A N.O.
Push button jog switch for table index only
Auto.
Hand
Selector
18 and 28 same
Forward index solenoid hand index only
265-tooth gear
20-tooth gear
57-tooth gear
15-tooth gear
Fluid motor
206A
Brake solenoid
2hp. power wrench
3/4hp. coolant
20hp. unit
10hp. unit
1 1/2hp. unit
2hp. index
4-pole magnetic contactor
Thermal relay one for each motor
211E 1 Forward solenoid
211E 2 Forward solenoid
211E 3 Forward solenoid
211E 1 Reverse solenoid
211E 2 Reverse solenoid
211E 3 Reverse solenoid
G.E. 415 P.N.O. Limit switches
Index plunger
C-711-T decelerating valve
C-412-N5 4-way valve
Pressure port
Tank port
Actuating switch
Rees No. 1330-R
Dog
Rees 1330-L
No. 1
No. 2
Port A
C-2-1612-AC solenoid valve
Rees No. 1330-L
Cylinder Port-A
Cylinder Port-B
C-252-A tuning valve
No. 3 to tank
Drain return to tank
SP10B-cylinder Vickers
Port B plug
Vickers feed control and relief valve F-206-B
Cor D
Port A
Port B
No. V.-105-A Vickers pump R.H. driven by 2hp. electric motor
Oil reservoir
2-pole magnetic contactor for start of head feed
Limit switch operated by dog on hydraulic unit
G.E. 415D
N.C.
BUICK CONNECTING ROD
Hydraulic Circuit Wiring Diagram for Vertical Indexing Machine
Greenlee Bros. & Co.

Interlocked Feed and Drive in Four-Station Machine

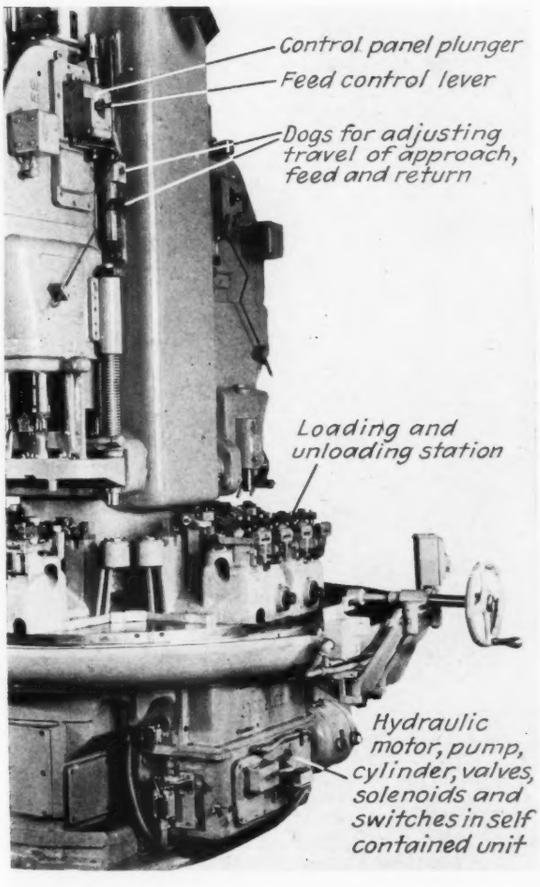
Hydraulic and electric circuits automatically control feeds and indexing movements of vertical four-station machine

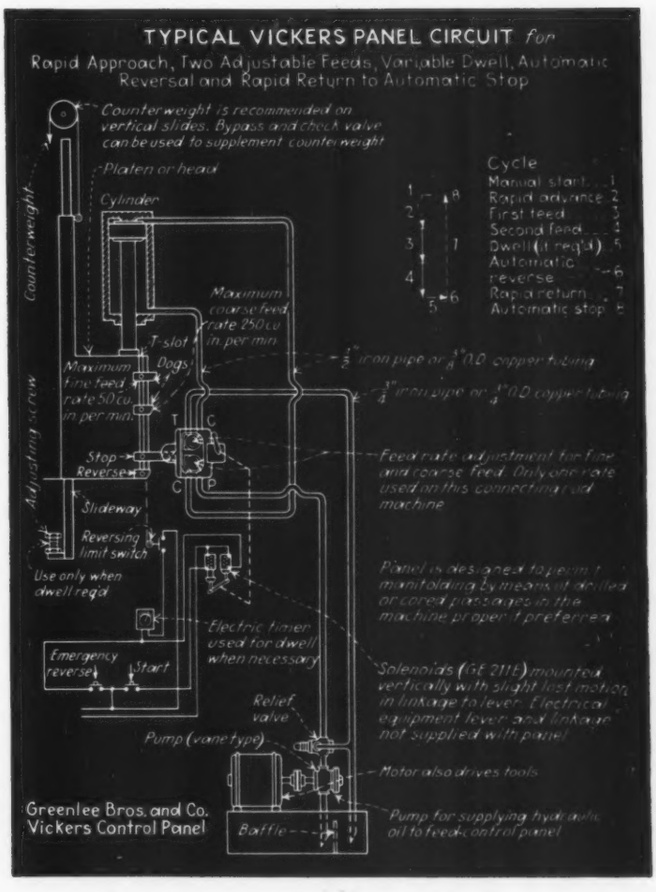

Each fixture holds four rod forgings clamped down by electric wrench
Drills and reams
Four independent tool carrying units each self-contained with motor for tools, pump and feed
Mills
Drills and reams
Saws off caps

MULTIPLE MACHINING operations performed simultaneously on special Greenlee automatic indexing machine include drilling and reaming holes, milling bolt bosses and sawing off caps of Buick connecting rod forgings. Electric wrenches clamp four forgings in each of four separate work supporting fixtures.

TABLE INDEXING mechanism is moved by a Vickers hydraulic motor which receives fluid under pressure from a continuously running electric-motor-driven pump. Easily removable for overhauling, a unit assembly at the base of the machine contains hydraulic motor, pump, cylinder, valves, solenoids and switches. All of the connections running between this unit and the indexing-mechanism controls are electrical.

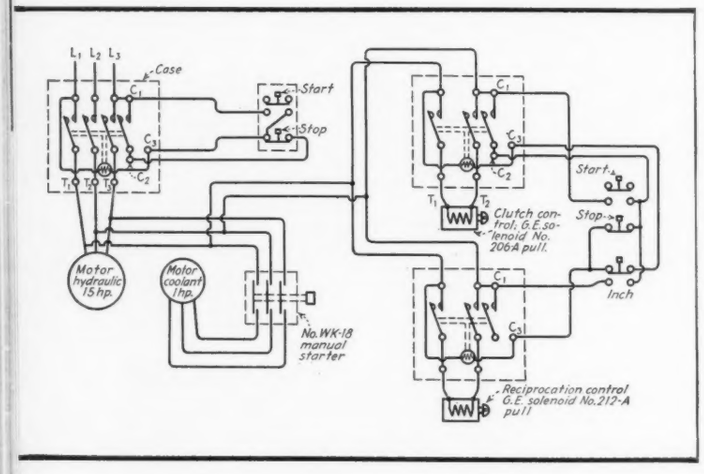
TOOL CARRYING units are self-contained with hydraulic feed system and motor for driving tools. Lengths of approach, feed and return movements are governed by positions of dogs on a slide. Dogs operate plungers on control panel. Interlocks prevent indexing until tools are clear of work and fixtures.

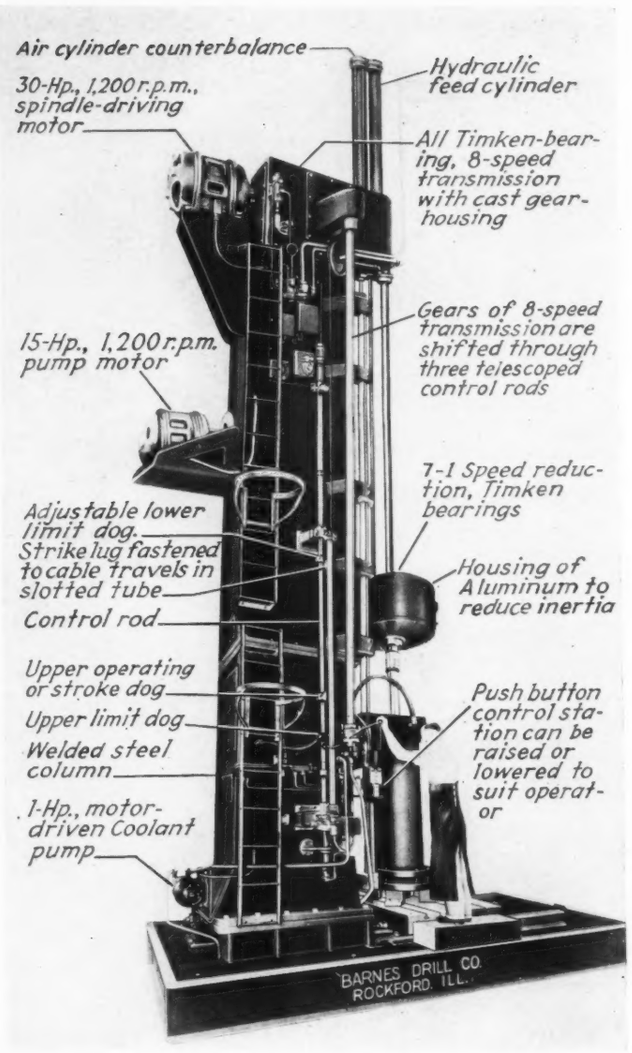

Control panel plunger
Feed control lever
Dogs for adjusting travel of approach, feed and return
Loading and unloading station
Hydraulic motor, pump, cylinder, valves, solenoids and switches in self contained unit


TYPICAL VICKERS PANEL CIRCUIT for
Rapid Approach, Two Adjustable Feeds, Variable Dwell, Automatic Reversal and Rapid Return to Automatic Stop
Counterweight is recommended on vertical slides. Bypass and check valve can be used to supplement counterweight
Platen or head
Cylinder
Counterweight
Adjusting screw
Cycle
Manual start 1
Rapid advance 2
First feed 3
Second feed 4
Dwell (if reqd.) 5
Automatic reverse 6
Rapid return 7
Automatic stop 8
Maximum coarse feed rate 250 cu. in. per min.
T-slot
Dogs
Maximum fine feed rate 50 cu. in. per min.
Stop-Reverse
Slideway
Reversing limit switch
Use only when dwell reqd.
Emergency reverse
Start
Electric timer used for dwell when necessary
Relief valve
Pump (vane type)
Feed rate adjustment for fine and coarse feed. Only one rate used on this connecting rod machine
Solenoids (GE 2111) mounted vertically with slight lost motion in linkage to lever. Electrical equipment, lever and linkage not supplied with panel
Motor also drives tools
Pump for supplying hydraulic oil to feed control panel
Baffle
Greenlee Bros. and Co.
Vickers Control Panel

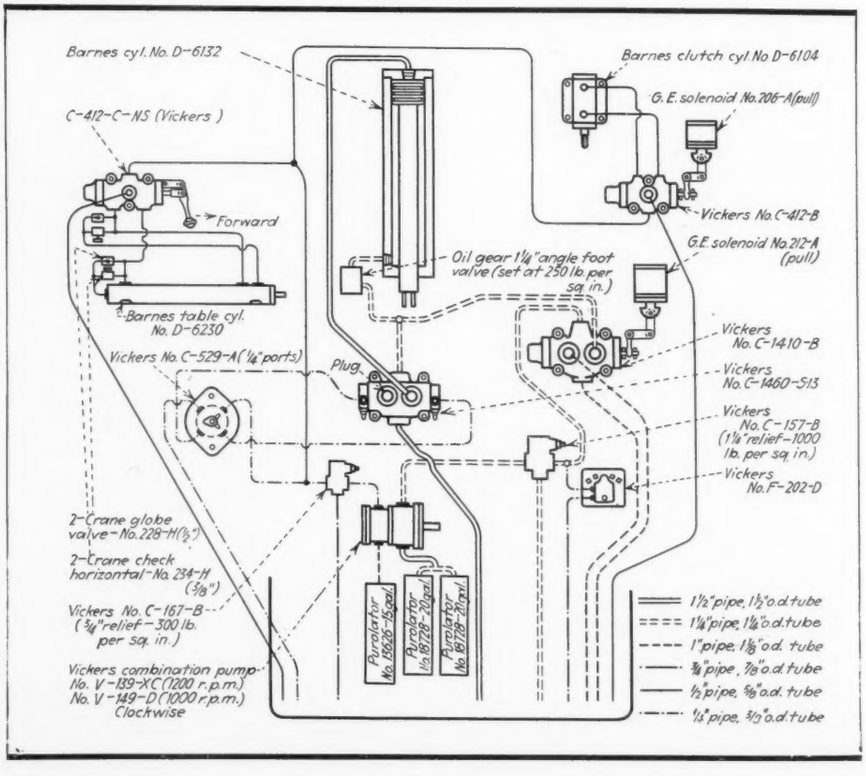
Air Cylinder Counterbalances Weight of Honing Spindle

Hydro-electric-pneumatic operations are all included in this large vertical honing machine built by Barnes Drill Company. Hydraulic and electric circuits are interlocked. Column is welded steel; gear box a steel casting




Air cylinder counterbalance
30-Hp., 1,200 r.p.m., spindle-driving motor
Hydraulic feed cylinder
All Timken-bearing, 8-speed transmission with cast gear-housing
Gears of 8-speed transmission are shifted through three telescoped control rods
15-Hp., 1,200 r.p.m. pump motor
7-1 Speed reduction, Timken bearings
Adjustable lower limit dog. Strike lug fastened to cable travels in slotted tube
Housing of Aluminum to reduce inertia
Control rod
Upper operating or stroke dog
Push button control station can be raised or lowered to suit operator
Upper limit dog
Welded steel column
1-Hp., motor-driven Coolant pump
BARNES DRILL CO. ROCKFORD, ILL.

AIR CYLINDER supplied with air at constant pressure, counterbalances weight of rotating drive spindle and tool. Machine is 31 ft. 4 in. high, spindle travel 90 in., swing 40 in., and designed to drive hones up to 30 in. diam. when driven by 50 hp. motor. Base is 14 ft. 4 in. by 7 ft. 2 in. Hydraulically operated work table is 40 in. by 60 in. and rolls in and out on tracks shown. Job being honed is a diesel engine cylinder sleeve 17½ in. diam. by 5 ft. long. Housing of 7 to 1 speed reduction gears on spindle is of aluminum in order to minimize inertia. Speed change gears are shifted through three telescoped rods.


Barnes cyl. No. D-6132
Barnes clutch cyl. No. D-6104
C-412-C-NS (Vickers)
G.E. solenoid No. 206-A (pull)
Forward
Vickers No. C-412-B
G.E. solenoid No. 212-A (pull)
Oil gear 1¼" angle foot valve (set at 250 lb. per sq. in.)
Barnes table cyl. No. D-6230
Vickers No. C-529-A (¼" ports)
Plug
Vickers No. C-1410-B
Vickers No. C-1460-513
Vickers No. C-157-B (1⅛" relief—1000 lb. per sq. in.)
Vickers No. F-202-D
2-Crane globe valve—No. 228-H (⅜")
2-Crane check horizontal—No. 234-H (⅜")
Vickers No. C-167-B (¾" relief—300 lb. per sq. in.)
Vickers combination pump No. V-139-XC (1200 r.p.m.) No. V-149-D (1000 r.p.m.) Clockwise
Purolator No. 18626-15 gal.
Purolator No. 18728-20 gal.
Purolator No. 18728-20 gal.
1½" pipe, 1⅝" o.d. tube
1¼" pipe, 1⅜" o.d. tube
1" pipe, 1⅛" o.d. tube
¾" pipe, ⅞" o.d. tube
½" pipe, ⅝" o.d. tube
⅛" pipe, 3/13" o.d. tube

Group Four

HEAVY PORTABLE MACHINERY

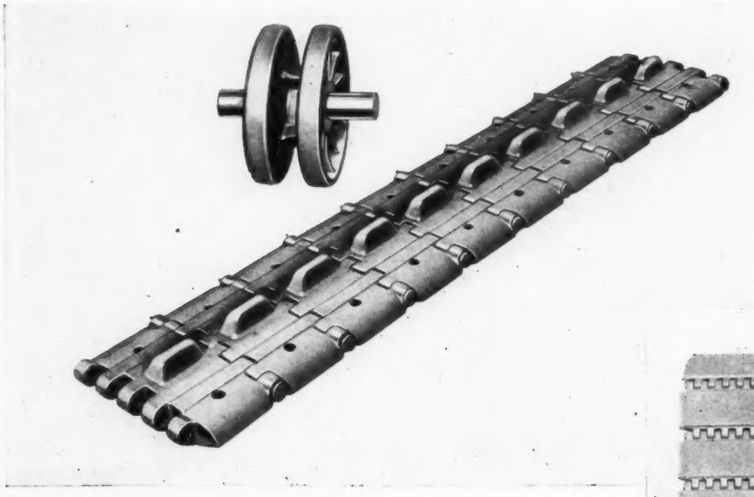
Tractors, power shovels, farm machinery, pavers, concrete mixers, portable elevators, mining and quarry machinery, road machinery

43 companies reporting

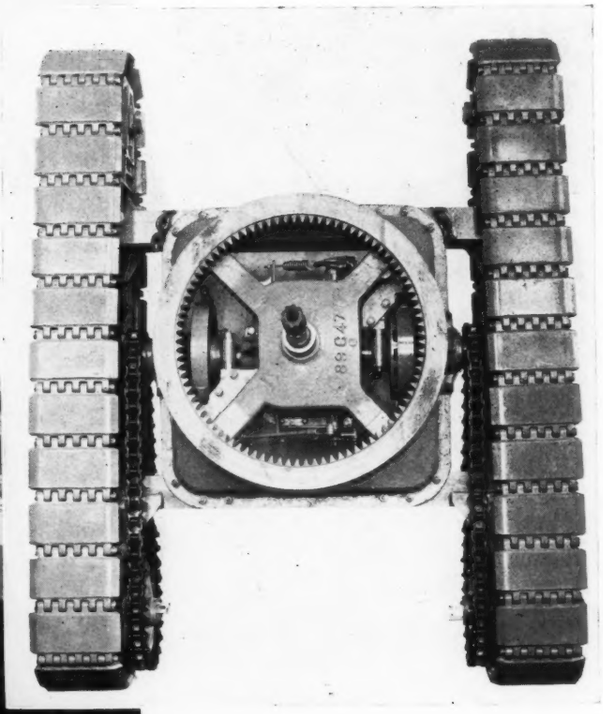
	Per Cent Using	Per Cent Increasing Use
TYPES OF CONSTRUCTION		
Fusion welding	60	40
Flame cut parts	65	37
Drop forgings	65	16
Resistance welding	42	16
Sand castings	91	9
Stampings	44	9
Tubular construction	42	7
Roll formed sheet	33	5
Molded plastics	28	5
DRIVES AND CONTROLS		
Chains	60	12
Variable-speed drives	30	12
Gears	77	9
Motor speed reducers	28	9
Flexible couplings	70	7
Hydraulic drives	21	7
Magnetic controls	51	7
Limit switches	46	2
BEARINGS AND LUBRICATION		
Ball or roller	88	49
Grease sealed	58	25
Grease gun fittings	93	23
"Oilless"	33	12
Needle	23	7
Unit bearing seals	33	5
TYPES OF FASTENINGS		
Nut locking devices	72	14
Hollow head screws	46	9
Self-tapping screws	25	5
Drive screws	37	2.5
MATERIALS OF CONSTRUCTION		
Heat-treated alloy steel	86	35
Low-alloy non-heat-treating steel	53	
Malleable iron	72	9
Alloy cast iron	58	9
Hard facing materials	30	7
Aluminum	30	5
Plain carbon steel	86	2
FINISHES		
Cadmium plating	26	5
Organic coatings	42	2
Chemical coatings	12	2
Chromium plating	9	2
Metallic spraying	9	2

Welded Construction Cuts Excavator Weight, Increases Strength

Gas-engine-powered Koehring Model 251 Shovel combines electrically welded rolled-sheet design, for such parts as turntable, with cast-steel construction for carbody and chrome-nickel steel for shafting. Shafts are all independently removable. Bearings are grease-sealed



WELDED CRAWLER SHOES with multiple hinged joints are connected by wear-resisting heat-treated pins. Double-faced rollers in each crawler carry the weight of the machine. Bearings are grease-sealed, and design results in self-cleaning assembly. Two traction speeds are provided, for heavy going or easy travelling, and machine has positive traction brakes.

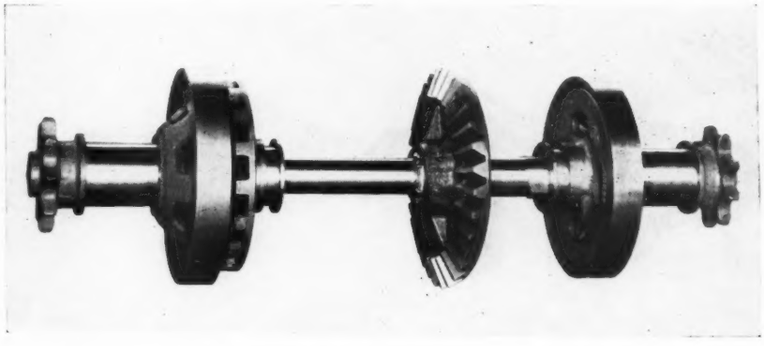


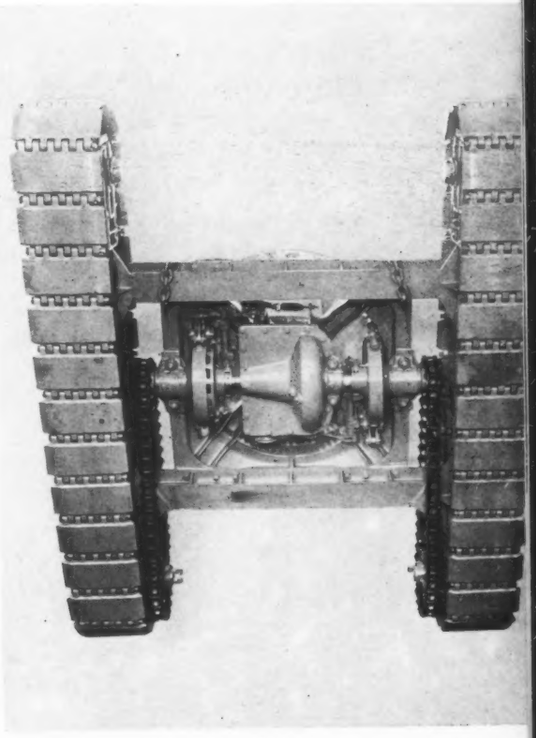
CAST-STEEL CARBODY, turntable gear, channel roller track and traction parts are combined in one assembly unit. For rigidity, carbody and channel roller track are cast integral. Hook turntable rollers reduce load on roller path. Centering pintle serves only to absorb horizontal thrust.

FULL-VISION CAB is equipped with safety glass for protection of operator. Dipper is of Man-Ten and abrasion-resisting steel, and dipper sticks are box-type, all-steel welded construction. Center of gravity is low, operating flexibility high.

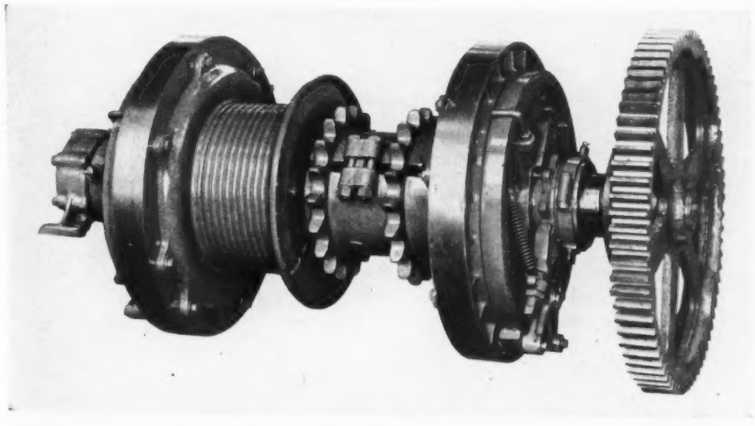
UPPER MACHINERY mounted on turntable. All gears and power-transmission chain drive are inclosed and run in oil. Shafts independently removable. Turntable is all welded construction, with diagonal bracing, and high-strength side members run full length of turntable. Machine is convertible to dragline, clamshell, crane or trench hoe. Drums are equipped with removable, interchangeable barrels. For dragline work, a tapered drum barrel can be installed to give increased efficiency. Rigid gear-case on right-hand side serves as side-stand. Side-stand on left-hand side is cast steel. Ample space is provided around machinery for safety during inspection and adjustment of motor and clutches. Motor (not shown), mounted at rear, is Wisconsin L4-type, 6 cylinder, $4\frac{1}{4}$ in. bore, 5 in. stroke, developing 71 b.h.p. at 1,400 r.p.m. Electric drive can also be used.

SPLINED TRACTION SHAFT (below) has only one bevel gear, which is inclosed and runs in oil. The two multiple jaw clutches, one for each crawler, operate independently and connect the driving shaft with the crawlers. Independent positive brakes are applied to the friction brake rims integral with the driving sprockets. Design permits short or long radius steering and locking of either or both crawlers. All controls, including those for traction brakes, are grouped in the cab within easy reach of operator. Two swing speeds are provided.





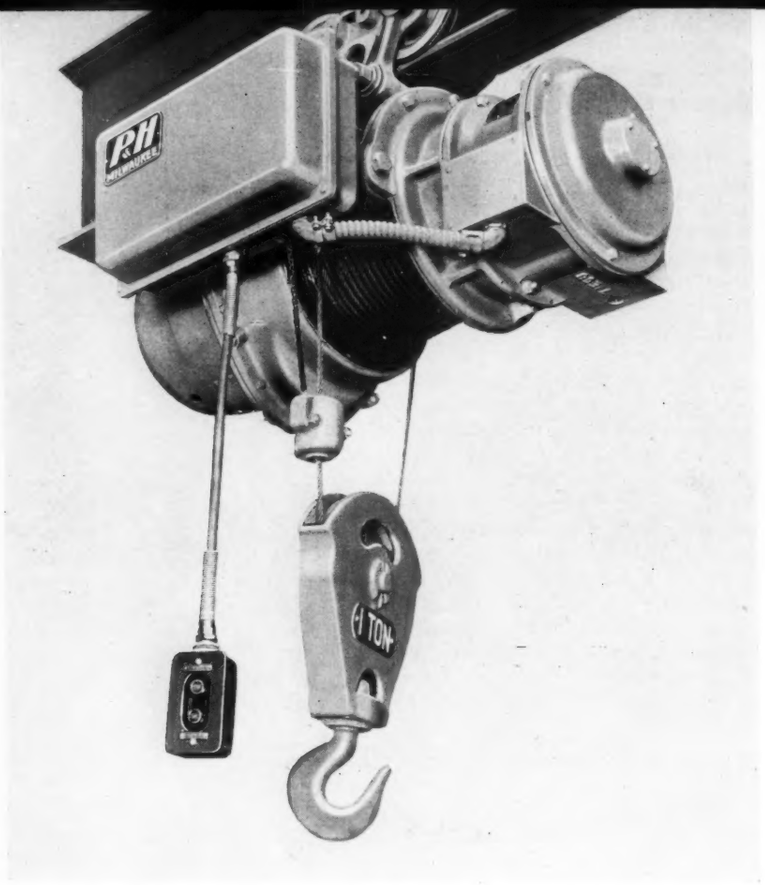
H-BEAM GIRDERS as can be seen from lower side of carbody (right), are reinforced with welded flange supports and transmit the load to the crawler frames. Also visible is method of mounting bevel-gear housing, with clutches and brakes. Crawlers are quickly removable.

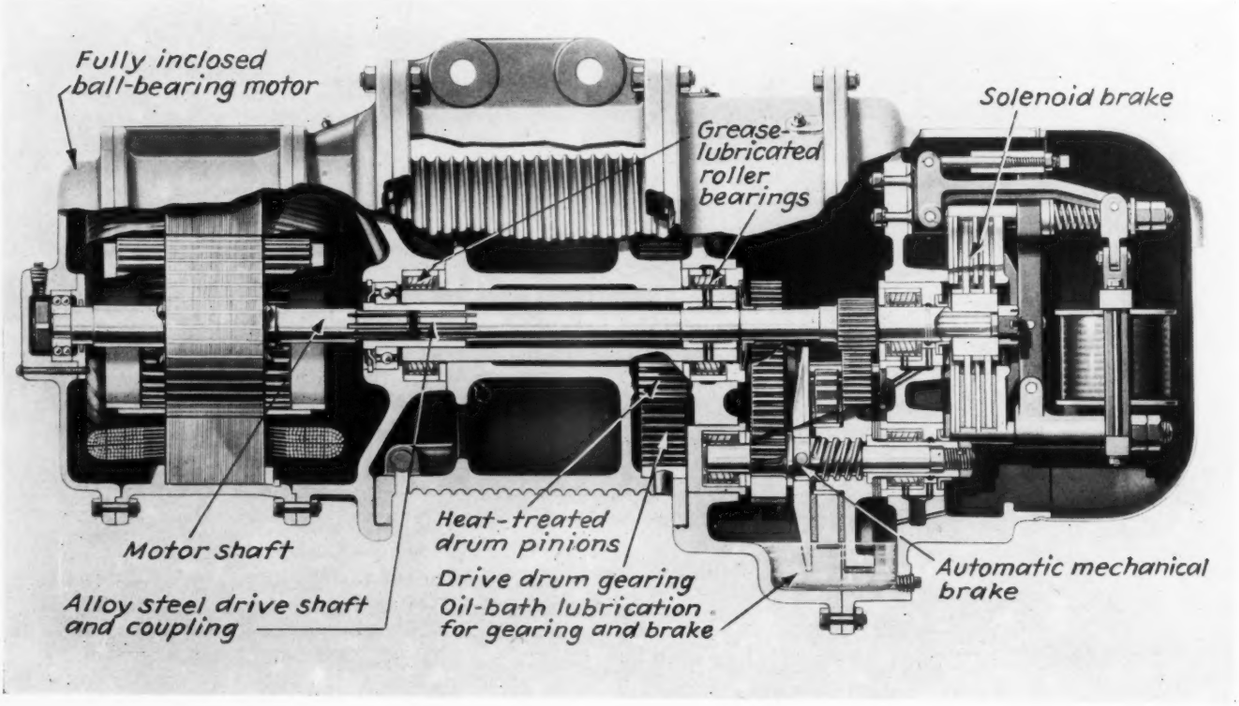


DRUM-SHAFT (left), revolving in anti-friction bearings, is driven by cut-tooth gear. Gear is inclosed in oil-tight cast gear case. Drums are of skeleton type and are equipped with large-diameter, removable barrels for convertibility and line speed changes. Hoist-drum barrels are grooved to wind towards center-line of machine, reducing cable wear. Drag-drum barrel is tapered to increase efficiency and prolong cable life.

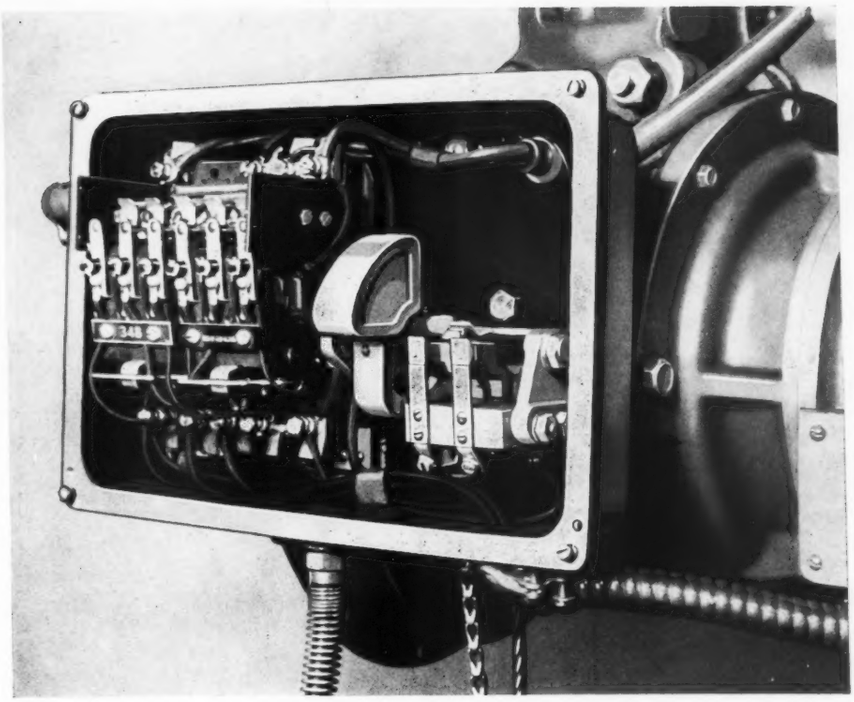
Positive Limit Switch and Dual Braking System in P&H Hoists

Other design features in line of 1 to 15 ton hoists built by Pawling & Harnischfeger include use of anti-friction bearings throughout, forged steel trolley wheels, splined shafts of alloy steel, heat-treated drum pinions, machine-grooved drums to lengthen cable life

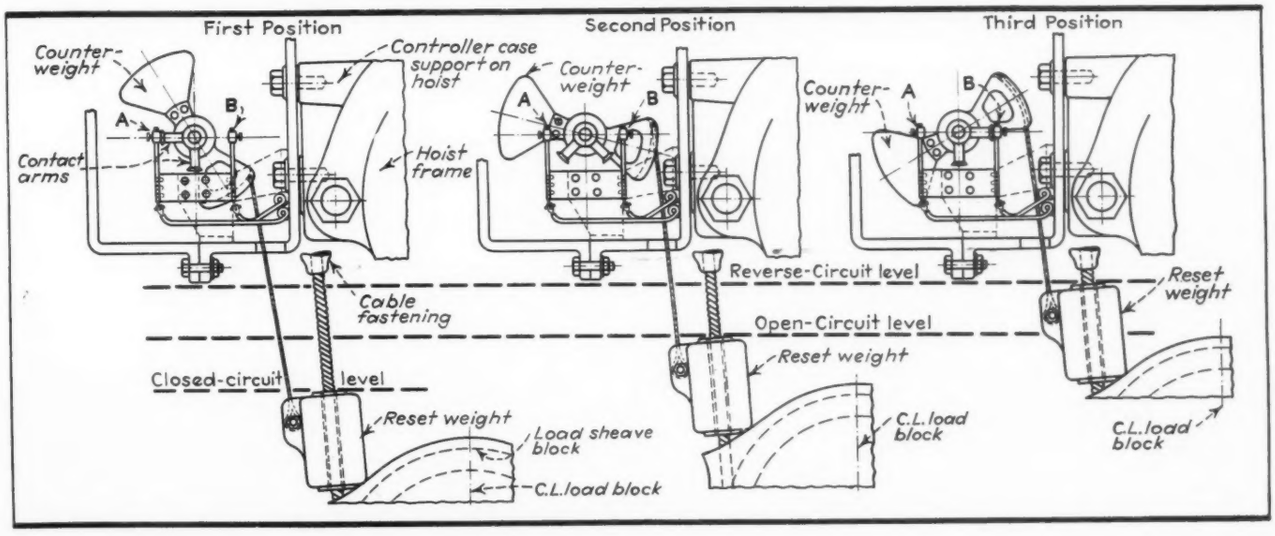


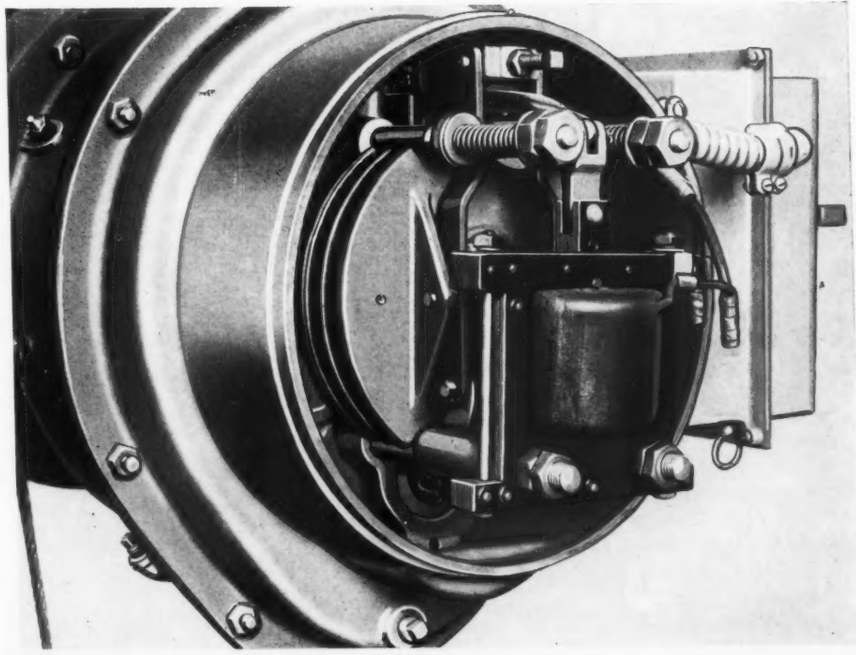


DUAL-BRAKING SYSTEM and other details of hoist are revealed by this "exploded" view. In addition to solenoid brake, for normal operation, automatic mechanical brake is provided to prevent sudden dropping of the load and subsequent injury or damage. Operating on the inertia principle, it functions through the first gear-reduction and can be adjusted without dismantling. All gears are machined from forged steel stock and are heat-treated, pinions being of 20- and 25-deg. stub-tooth design. As shown, they are lubricated by an oil bath located for drip-proof service. Heavy-duty hoist motors are used, squirrel-cage type for single-speed hoists and slip-ring type for variable-speed units. All supporting members are cast steel.



LIMIT SWITCH (left), located in control cabinet, has three positions as shown in diagram below. Chain-connected to it is the reset weight which encircles hoisting cable and is lifted by sheave block as latter nears upper limit of travel. When reset weight is below closed-circuit level, contact *A* of limit switch is closed, permitting hoist to be operated entirely under control of rope-pendant or pushbutton switches. When sheave block lifts reset weight above open-circuit level, power circuit to motor and solenoid brake is opened and latter is set. If brake should be out of adjustment and block should continue to rise, then, when reset weight reaches reverse-circuit level, contact *B* of limit switch closes and reverses motor. If the reset-weight chain should break, hoist will not operate in hoisting direction until repair is made.

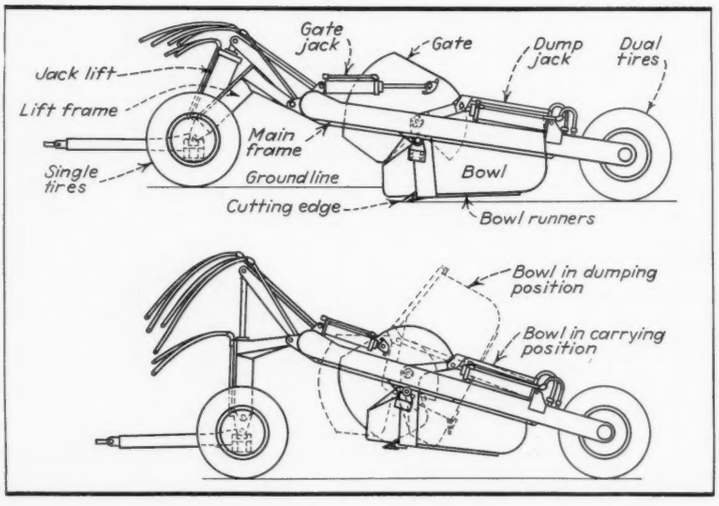




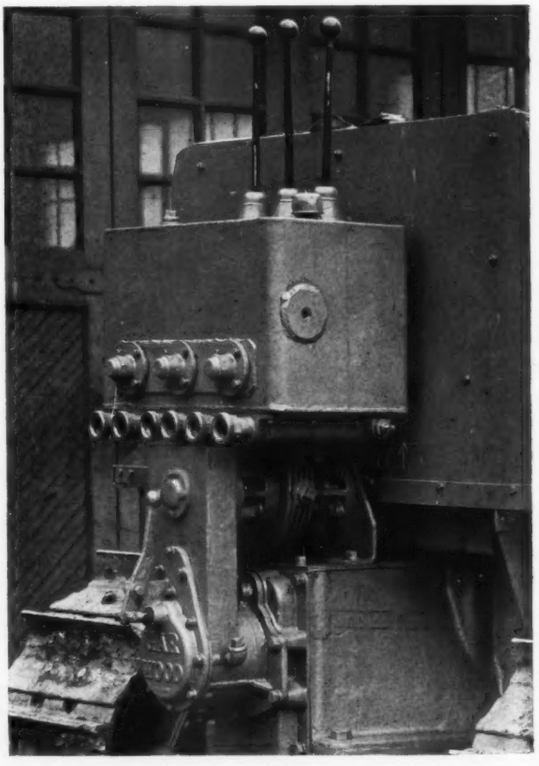
SOLENOID BRAKE (left) is of multiple-disk type, with broached wheels. Normally set, it operates through reduction gears and stops hoists when power is removed from motor. When hoist control switches are operated, for movement in either direction, power is applied to motor and to solenoid, actuating it and releasing brake. Adjustment nuts are readily accessible upon removal of drawn endshield from hoist housing.

Hydraulic Unit Centralizes Pump, Valves, and Oil Tank

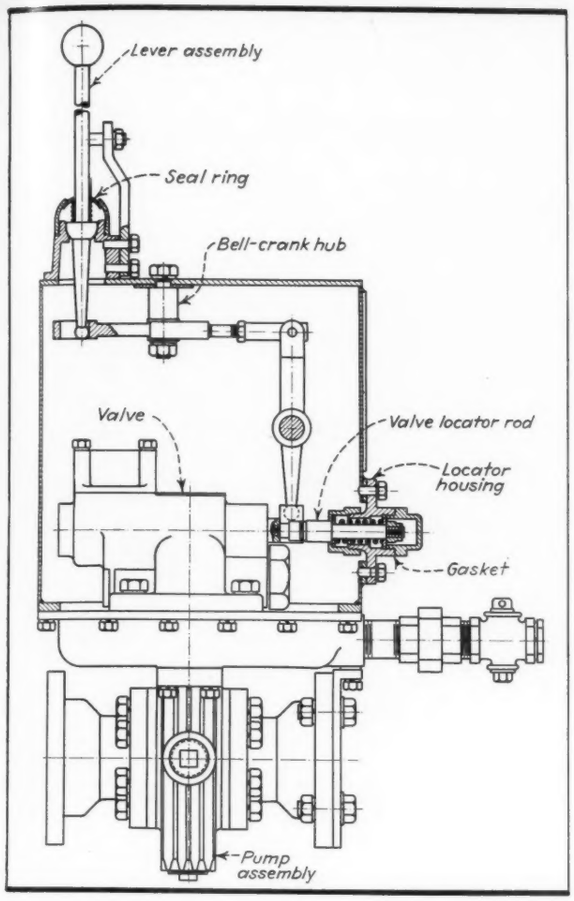
Attached to power take-off of tractor, it supplies pressure oil and controls all operations of scraper unit built by Gar Wood



OPERATING POSITIONS (above) show how wheelbase changes to provide for both loading and hauling. Hydraulic jacks afford precision control of cut, rate of discharge, depth of spread, and positive gate action. Bowl runners, of hard manganese steel, are replaceable.



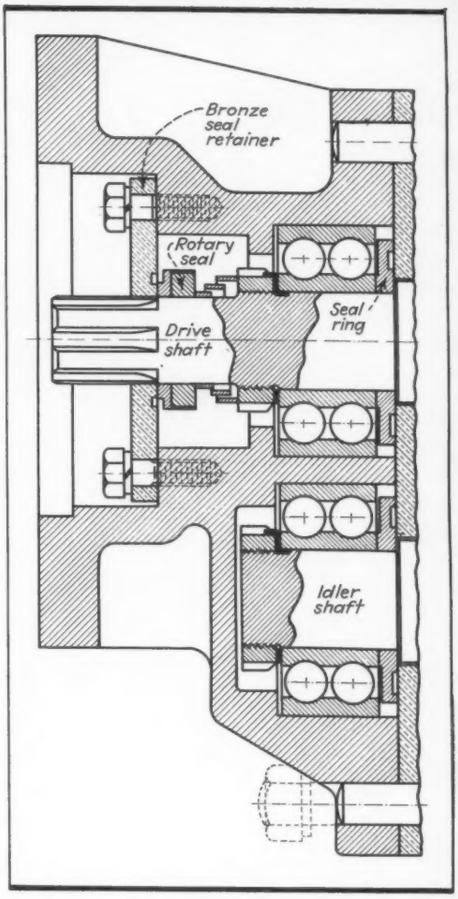
ALL IN ONE UNIT (right), are the hydraulic pump, triple-valve assembly, and oil tank. Arranged for universal mounting on back of tractor, the pump can be reversed end-for-end to suit direction of rotation of power take-off. Pump is assembled without gaskets.

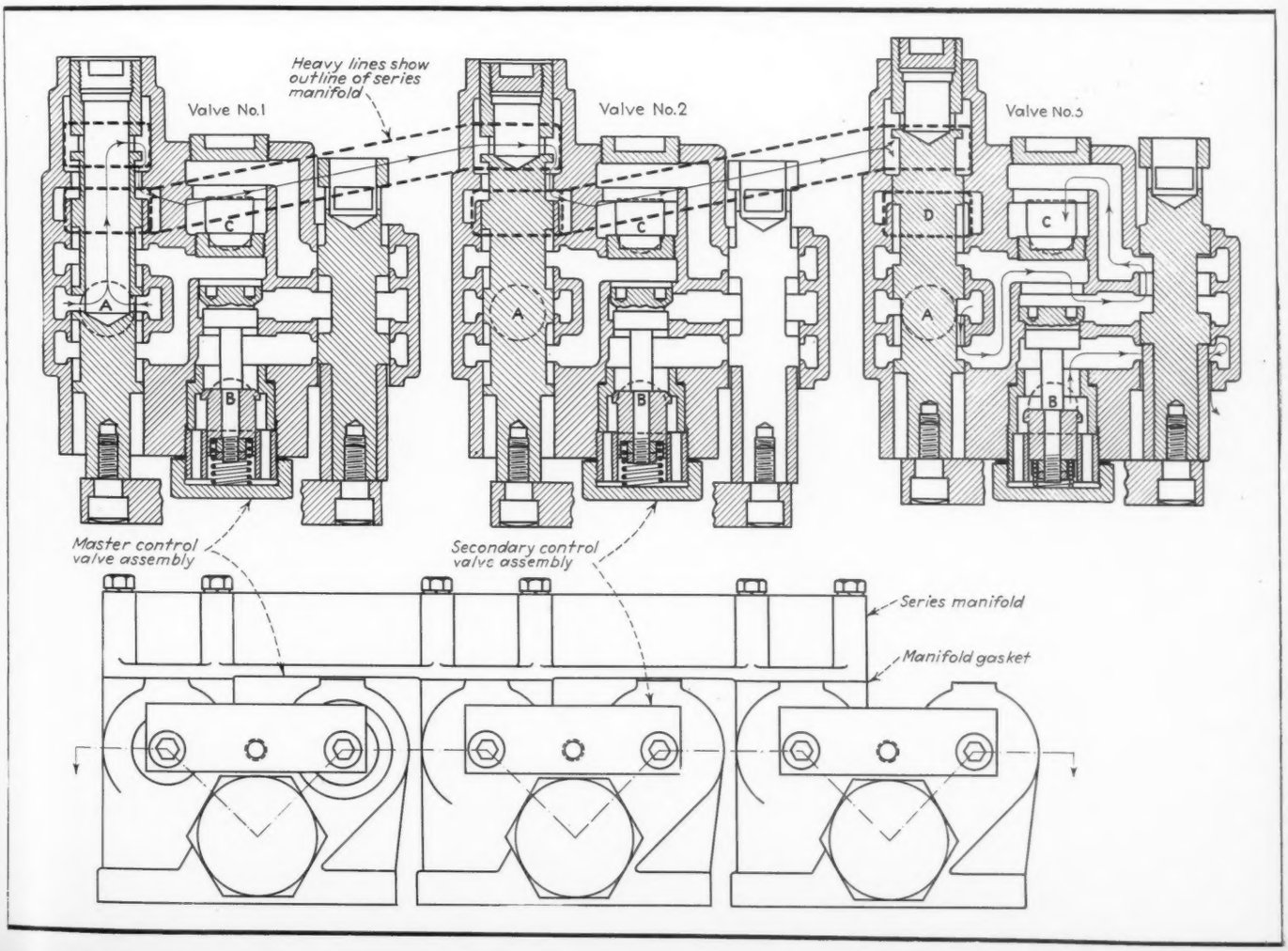


PIPING IS ELIMINATED between the valves and the oil tank (left) by submerging the valves in the tank.

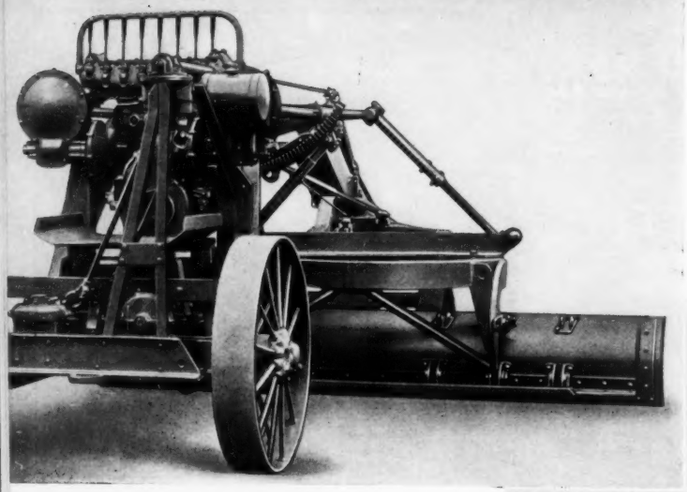
PUMP SECTION (right) shows details of seals and shaft bearings. To avoid leaks at shaft, a duct (not shown) runs from seal recess to low-pressure side of pump.

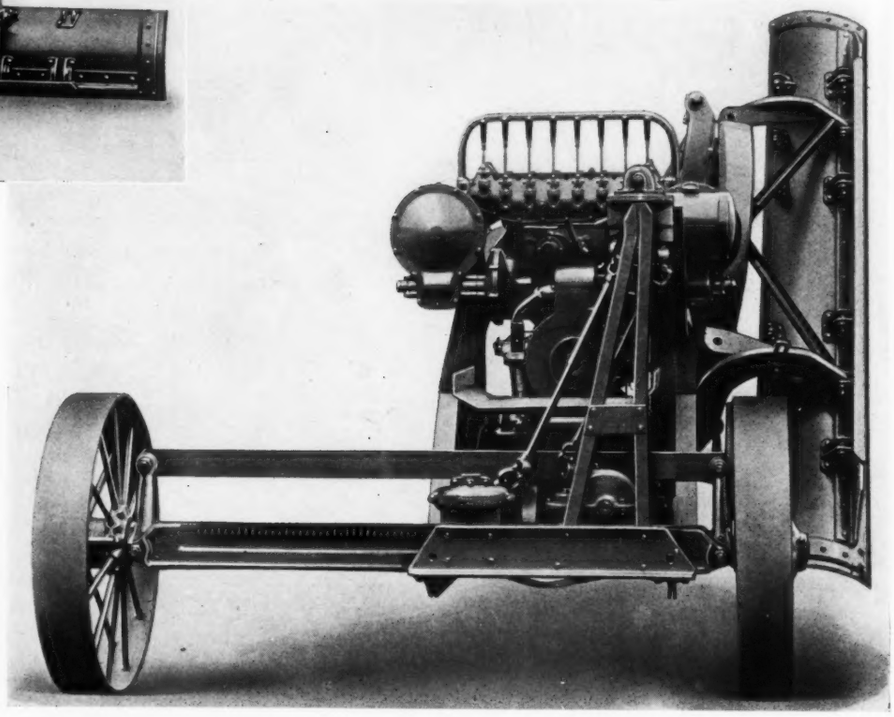
VALVE ASSEMBLY is shown below with valve No. 3 operating and other two valves in hold position. Pressure oil enters all valves through ports *A*. In valve No. 3, it flows through and out *C* to bottom of jack. Poppet at *B* is opened by pressure from *A*, permitting oil from top of jack to flow out into tank. Pressure oil to other valves flows through them and series manifold until stopped at valve No. 3. If latter were also in hold position, oil would pass through *D* out into tank, effecting a complete by-pass condition in the system.





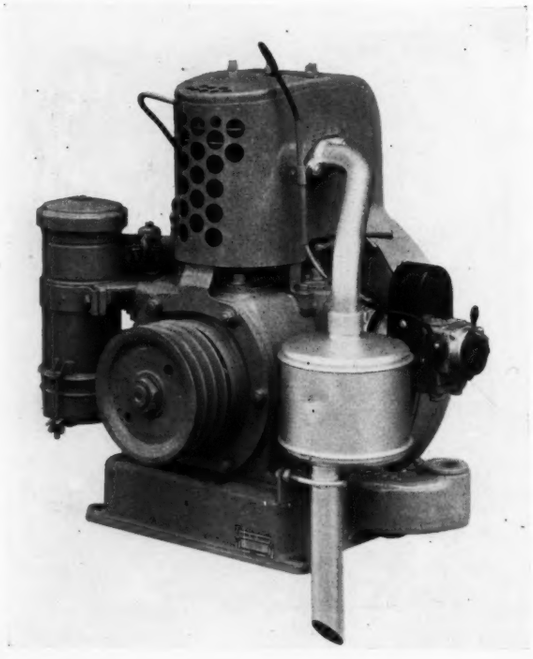
Versatile Control-Power Transmission in Caterpillar Grader



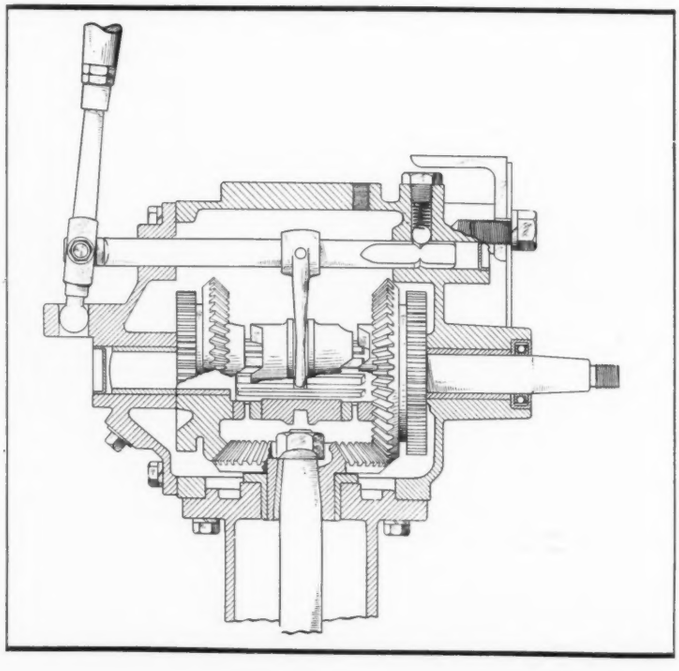


Universal joints and telescoping links, operated from gear box through 8 power-control units, accomplish all adjustments of blade, scarifier, frame and leaning wheels. Power from engine is transmitted to gear box through triple V-belt drive. Single box-type frame is made of two 9-in. ship channels, with steel plates welded on top and bottom for rigidity

GRADER ENGINE, located below gear box, supplies power by which all adjustments of the machine are made. Developing 8 h.p., it is equipped with counterbalanced crankshaft mounted on tapered roller bearings, removable cast-aluminum cylinder head, and flyball governor.

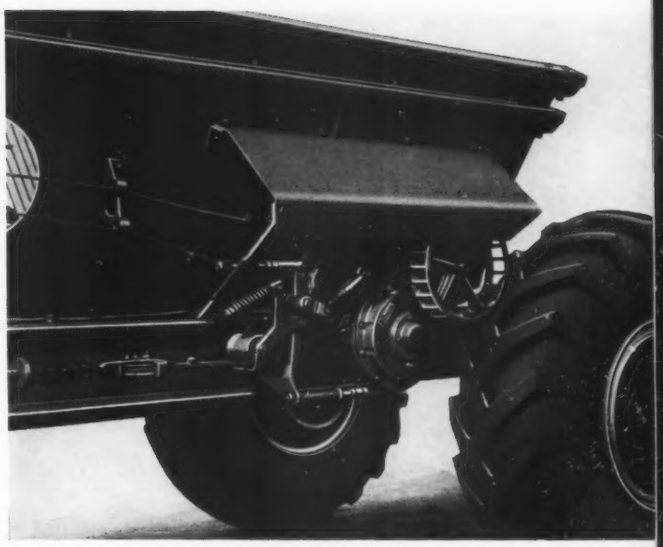


MECHANICAL "VALVE," (below) controls application of engine power. Gear box contains two opposite trains of machine-cut, heat-treated gears with beveled jaw-clutch faces, driven by a bevel gear mounted on the main drive shaft. Double beveled jaw clutches between these gears are shifted to engage gear giving desired action, one way for forward and other for reverse.



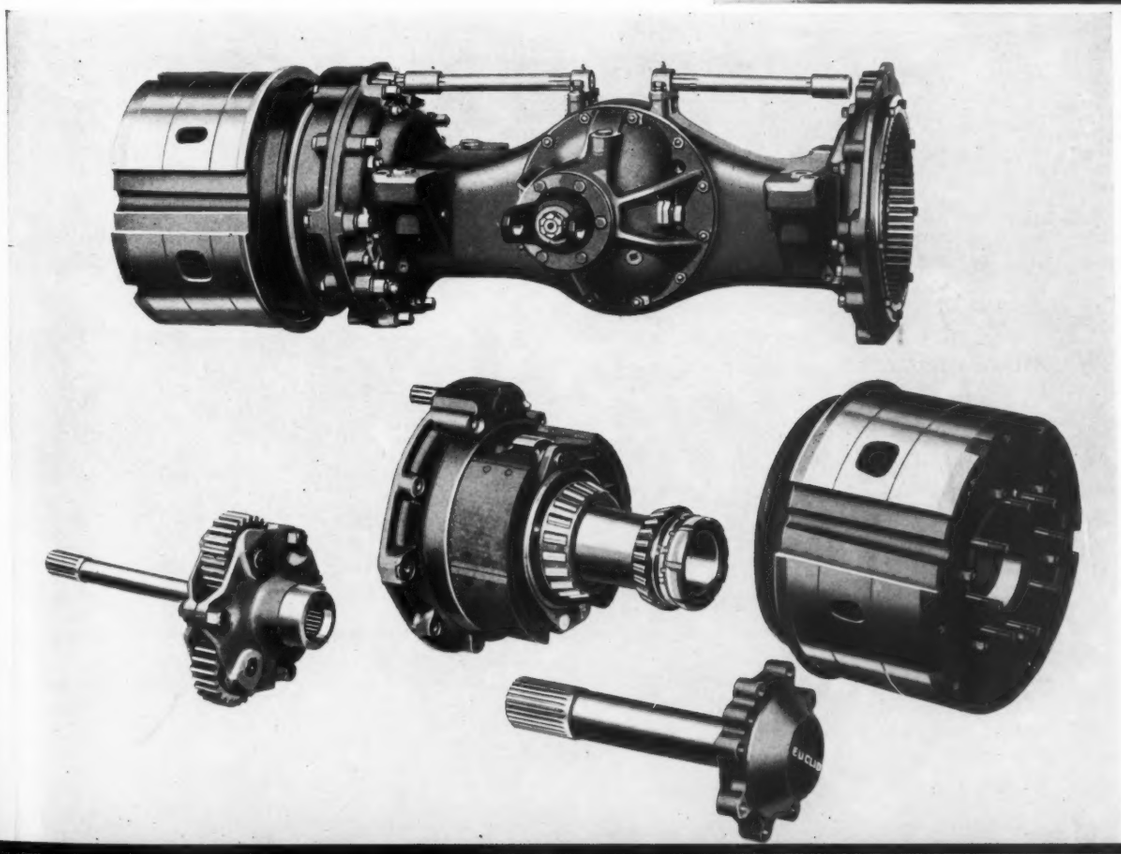
Wheel-Operated Mechanism Closes Bottom Doors on "Trak-Truk"

Planetary final drive is also feature of Euclid tractor-trailer for heavy-duty dirt haulage and industrial materials handling



CABLE DRUM, operated through gear reduction by wheel in contact with left trailer tire, hauls in door-closing cable. When doors are fully closed and closing cable is under tension, automatic wind release functions and moves wheel away from tire, the mechanism being actuated by the tension in the cable. Hand levers on trailer drawbar operate door-opening trip and wind-engagement. Wind mechanism gears are inclosed and run in oil.

PLANETARY SYSTEM between axle shaft and stub axle shaft serves as second reduction. Consists of sun pinion on axle shaft, outside planetary ring gear mounted in end-bell housing and three intermediate planet pinions mounted on spider of stub axle. Gives 20.6:1 total reduction.



Group Five

TRANSPORTATION EQUIPMENT

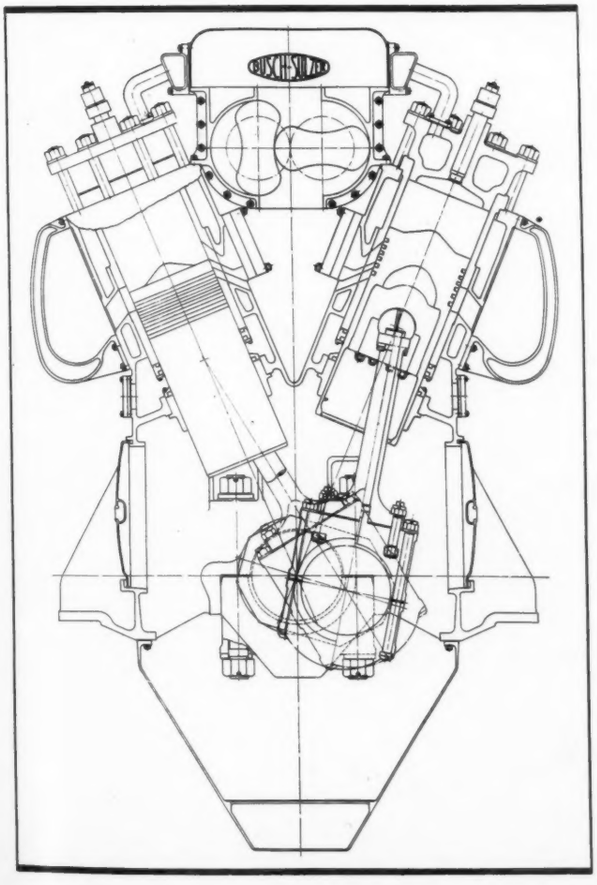
Trucks, buses, passenger automobiles, railway cars, airplanes, commercial trailers, fire apparatus, freight cars and locomotives

47 companies reporting

	Per Cent Using	Per Cent Increasing Use
TYPES OF CONSTRUCTION		
Stampings	72	28
Drawn sections	60	25
Molded plastics	60	25
Fusion welding	60	25
Sand castings	72	19
Drop forgings	62	19
Rolled-formed sheet	49	19
Resistance welding	42	19
Die-castings	34	11
Flame cut parts	34	11
DRIVES AND CONTROLS		
V-belts	45	21
Hydraulic drives	28	11
Gears	49	6
Flexible couplings	28	4
Variable-speed drives	19	4
Thermostatic controls	38	4
Automatic timers	17	4
Magnetic controls	30	2

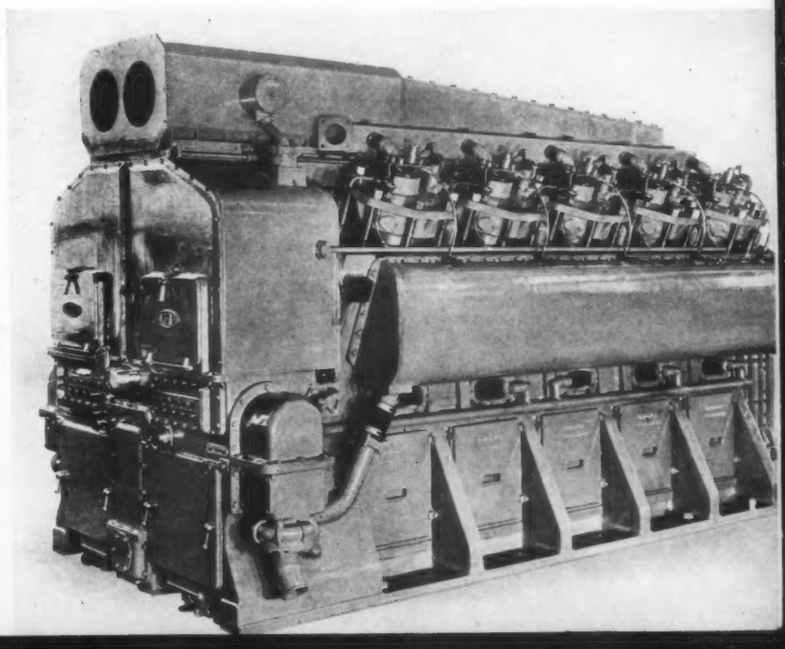
	Per Cent Using	Per Cent Increasing Use
BEARINGS AND LUBRICATION		
Grease-sealed	64	25
Anti-friction	75	23
Unit bearing seals	21	9
Needle	34	6
Grease gun fittings	62	—
Sleeve type	34	—
TYPES OF FASTENINGS		
Self-tapping screws	55	21
Nut locking devices	64	15
Hollow head screws	45	11
Drive screws	32	9
MATERIALS OF CONSTRUCTION		
Heat-treated alloy steel	72	26
Aluminum	70	15
Alloy cast iron	38	15
Low-alloy non-heat-treating steel	38	15
Stainless steel	60	13
Plain carbon steel	68	6
Malleable iron	38	6
FINISHES		
Chromium plating	49	15
Chemical coatings	32	8
Organic coatings	62	4
Cadmium plating	60	4
Anodic coating	38	4
Metal spraying	19	2

World's Largest Diesel Locomotive Engine—2,000 Horsepower



NOW IN SERVICE on Illinois Central, the largest single unit diesel-electric transfer locomotive is powered by a Busch-Sulzer V-type 2 cycle, single acting, 10 cylinder diesel. Cylinders are 14 in. bore, 16 in. stroke; brake hp. is 2,000. Roots type rotary blowers for scavenging air are mounted at the top between the cylinders as shown in the cross-section view.

Pistons are cast aluminum. Working cylinders have upper and lower liners made of special alloy cast iron. Upper liner contains the scavenging and exhaust ports. Gap between liners permits observation of pistons while engine is running. Upper liners are fastened only at the upper end, thereby permitting free expansion. Lower liners are fastened only at lower end. All important parts are pressure lubricated. Engine control servomotor and governor relay are operated by oil.

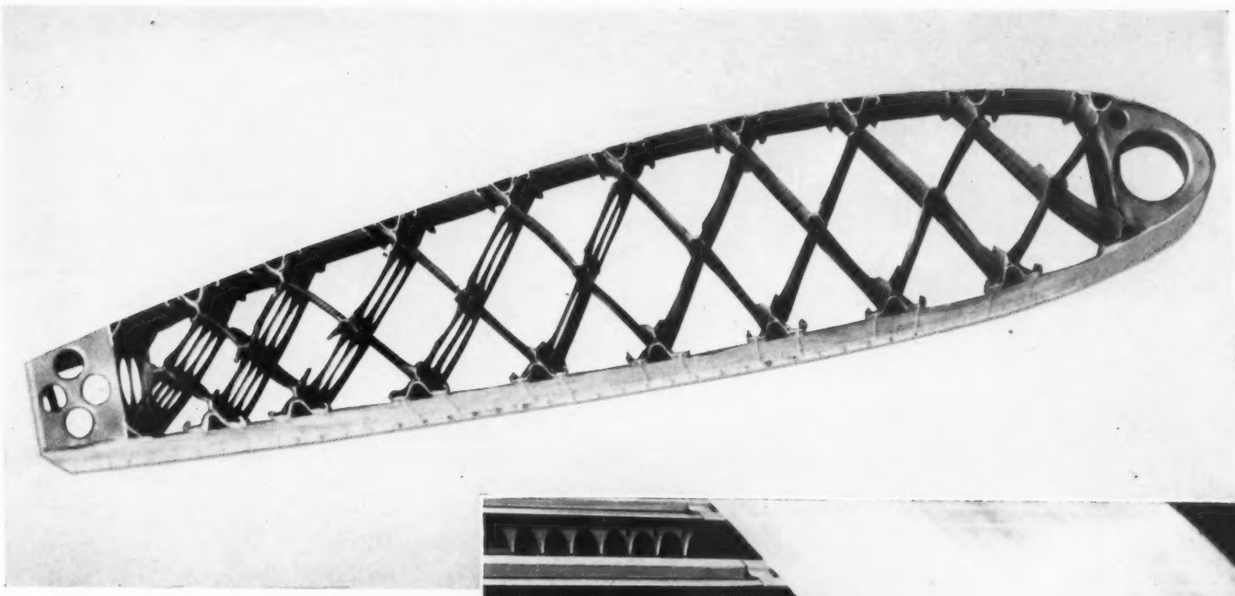


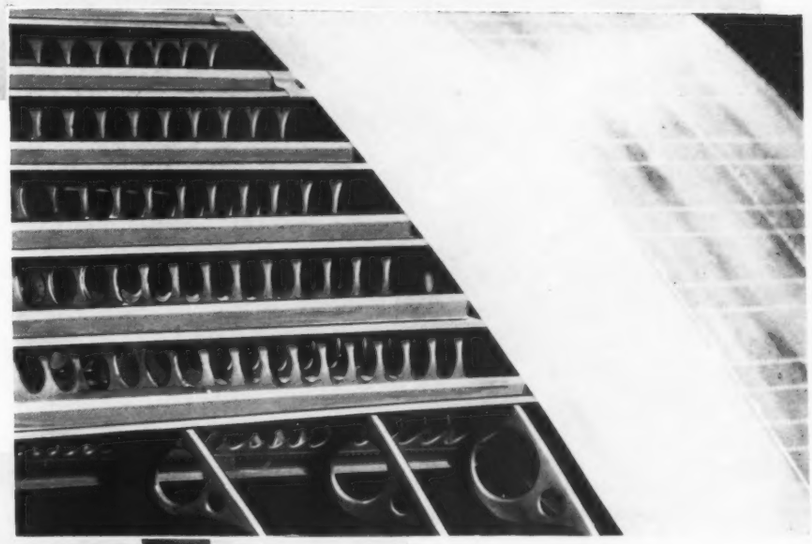
Rigidity of Thin-Sheet Design Featured in Barkley-Grow Plane

Multi-cellular construction gives the wing a high strength-weight ratio and good deflection properties; semi-monocoque fuselage design gives a roomy shell having a thin-sheet wall with good resistance to buckling

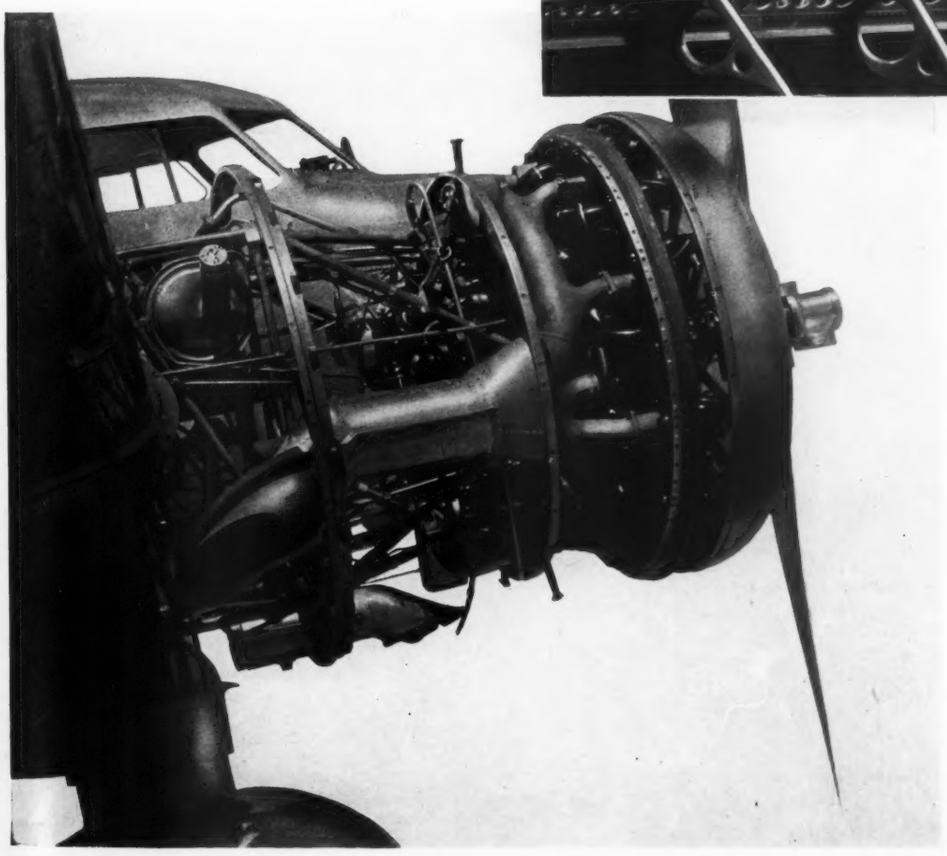
ROLLED-SHEET SECTIONS are used as stiffeners in this general-purpose airplane (above). Stiffeners are so spaced and located that they give a smooth contour to the outer sheath of Alclad and a sturdy structure in which drumming is eliminated. The wing is designed with a multiplicity of full-length span-wise webs, which make it extremely stiff and free of tendency to flutter.

LONGITUDINAL STRINGERS made of 17ST aluminum alloy pass through rings of the same material. They have been arranged to give panels of a minimum size. Bulkheads at front and rear of cabin provide stabilizing effect against buckling and torsional stress. Cabin windows are of Plexiglas. This highly flexible plastic with about half the weight of glass transmits less sound than glass. Decibel readings in the low seventies show how well the cabin has been sound-proofed.



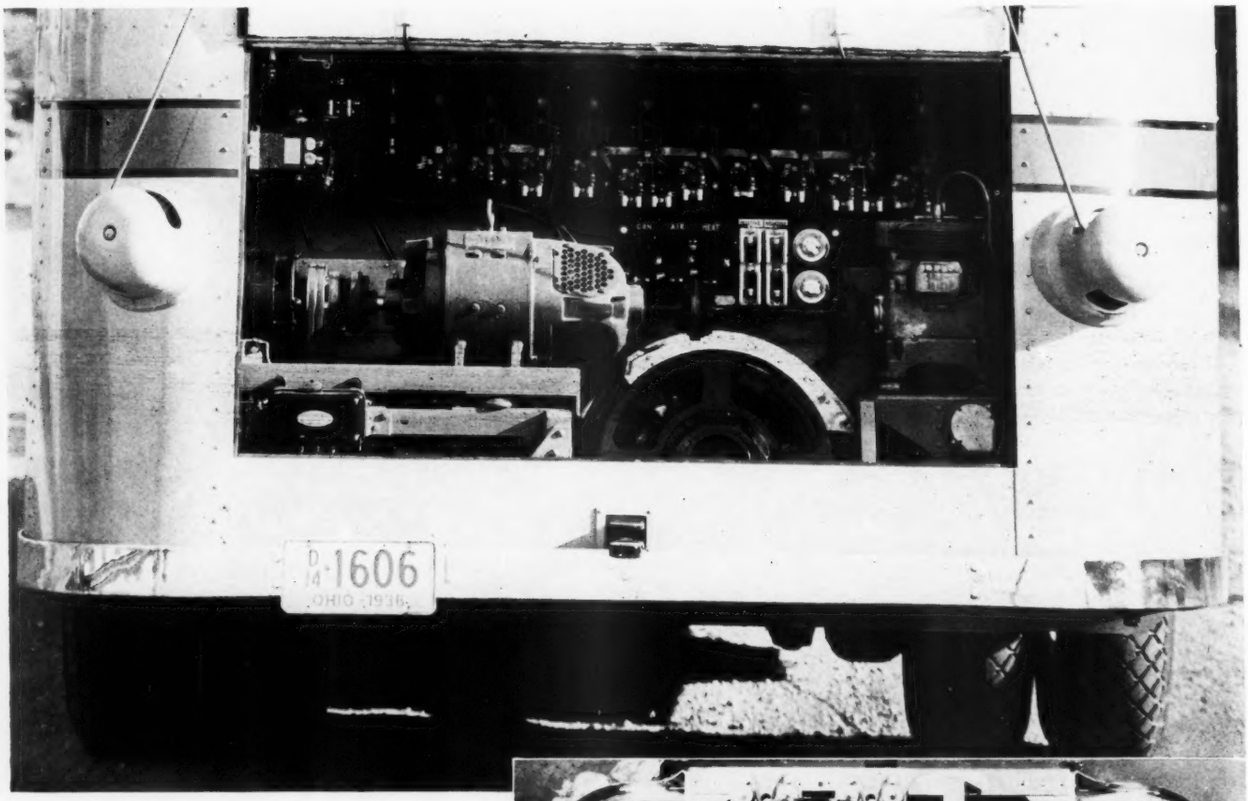


WING STRUCTURE is made entirely of 24ST aluminum alloy of thin gage. High strength-weight ratio of the wing assembly is obtained by the use of a great number of thin shear members lightened by large circular flanged holes, elimination of ribs. Designed for facility of handling and of production, the wing is made in three sections; tip, outer panel and three spars which are the basic supports for the fuselage, motors and landing gear.

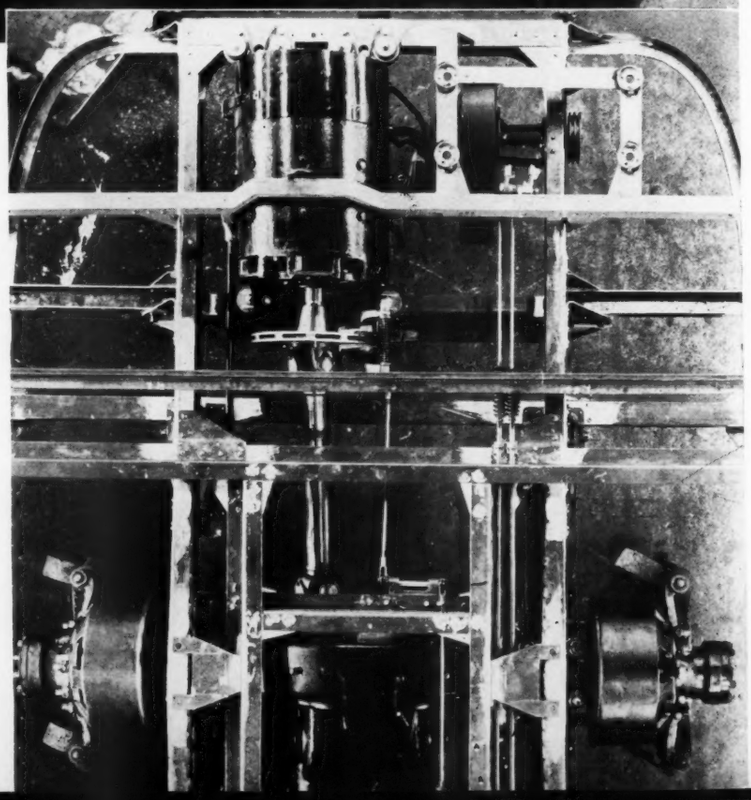


WELDED-STEEL TUBES support the power plant. Mounting is attached to the semi-monocoque structure which forms the rear half of the engine nacelle. A stainless sheet-steel bulkhead separates the two, supplies torsional strength, acts as firewall. Vibration problem is solved by inserting dampers in the mount; also, by mounting seats in rubber and upholstering them with lastex-treated hair and rubber.

Space-Economy Emphasized in Single-Motor Trolley Coach



REAR COMPARTMENT of the Twin Coach 42-passenger trolley bus with transit-type body houses drive motor, auxiliary generator, and air compressor, as well as associated control for all three. Motor is of series type, 125 h.p., 600 volts.



MOTOR AND REAR AXLE are connected by drive shaft through two universals, as revealed by this view taken during construction. Parking brake can be seen on motor shaft. Control is rheostatic and of remote type, the master controller being foot-operated.

Group Six

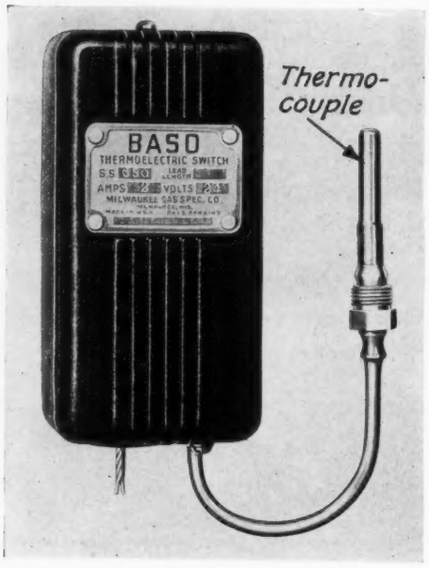
INSTRUMENTS

Electric meters, gages, x-ray equipment, cameras, thermostats, testing devices, electrical devices, control valves

29 companies reporting

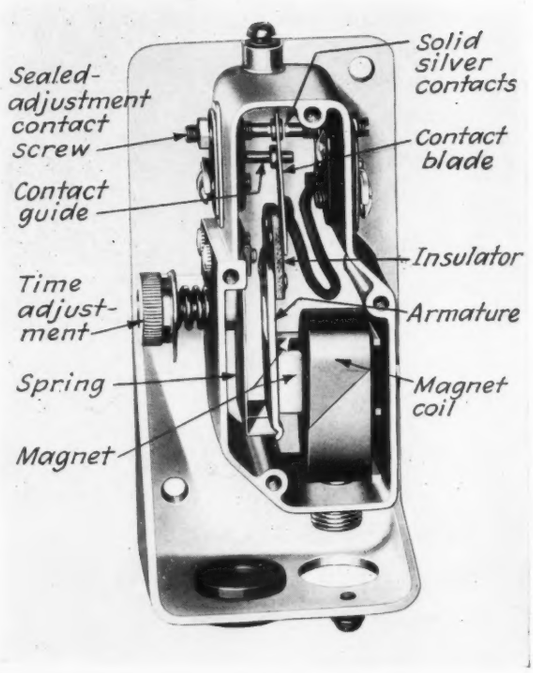
	Per Cent Using	Per Cent Increasing Use
TYPES OF CONSTRUCTION		
Stampings	83	41
Molded plastics	100	38
Die-castings	69	24
Resistance welding	45	17
Drawn sections	45	14
Fusion welding	34	14
Wire	62	7
Laminated plastics	45	7
Drop forgings	45	7
DRIVES AND CONTROLS		
Relays	41	10
Thermostatic controls	34	10
Special motors	34	7
Rheostats	34	7
Gears	48	3
Automatic timers	34	3
V-belts	24	—
BEARINGS AND LUBRICATION		
"Oilless"	21	7
Sleeve type	38	3
Needle	17	3
Grease-sealed	14	3
Simple oil covers	38	—
Grease gun fittings	24	—
TYPES OF FASTENINGS		
Drive screws	48	14
Self-tapping screws	62	10
Nut locking devices	41	10
Hollow head screws	41	3

	Per Cent Using	Per Cent Increasing Use
MATERIALS OF CONSTRUCTION		
Stainless steel	76	21
Laminated metals	41	14
Heat-treated alloy steel	38	14
Beryllium copper	34	14
Copper, brass, bronze	96	10
Aluminum	76	10
Nitralloy	21	7
Hard facing material	7	7
Monel	48	3
Zinc	41	3
FINISHES		
Chromium plating	59	21
Organic coatings	59	14
Cadmium plating	86	10
Chemical coatings	28	3
Anodic coating	28	3
Metallic spraying	17	3



Sealed Switch-Contact Adjustment Assures Positive Shut-Off Action

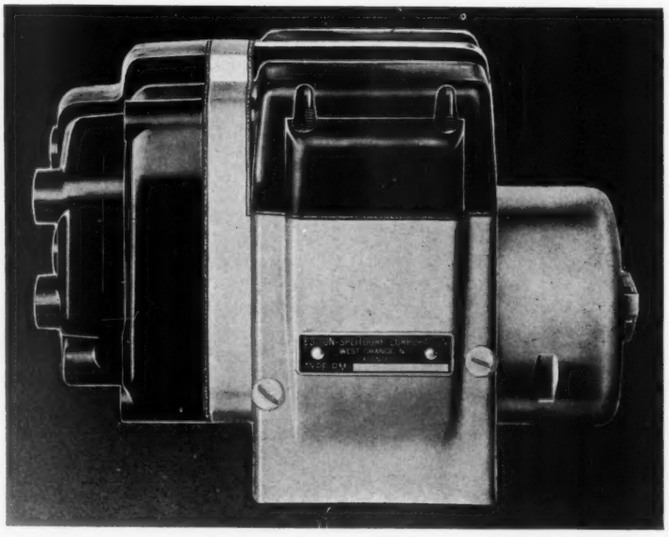
THERMOELECTRIC in operation, Milwaukee Gas Specialty's "Baso" Series 600 automatic switch is a safety device for preventing the escape of unburned gas in the event of pilot failure. When pilot is lighted, flame heats thermocouple, generating a current which energizes electromagnet.

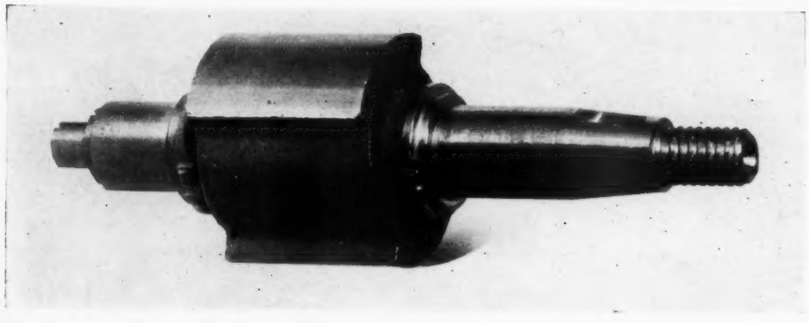


MAGNET-ARMATURE SPRING causes snap action of silver contacts, when electromagnet is energized or de-energized. Spring adjustment permits variation in time required for switch to operate, and it is the only adjustment which can be made in the field. Contact adjustment is made at the factory and is sealed so that it is impossible to maladjust the switch to the extent that it will fail to break the control circuit when the pilot burner is out. Purpose of the spring adjustment is to correct the time of operation for variations in the character of the pilot-burner flame.

Permanent-Magnet Rotor Features Compact, Light-Weight Magneto

WEIGHING LESS THAN FIVE POUNDS, this new magneto manufactured by Edison-Splitdorf departs from former practice, in which stationary magnets surrounded a revolving armature, and instead has a permanent-magnet rotor with stationary field coils. The rotor is of the new aluminum-nickel-cobalt alloy, "Alnico," and this, to a large extent, accounts for the small size and light weight of the unit. For moisture and dust protection, the device is inclosed in a one-piece die-cast housing. The circuit-breaker is gear-driven and operates at only one-third to one-half former speeds, thus greatly reducing wear. A cartridge-type condenser is used and the high-tension coil is vacuum-impregnated.



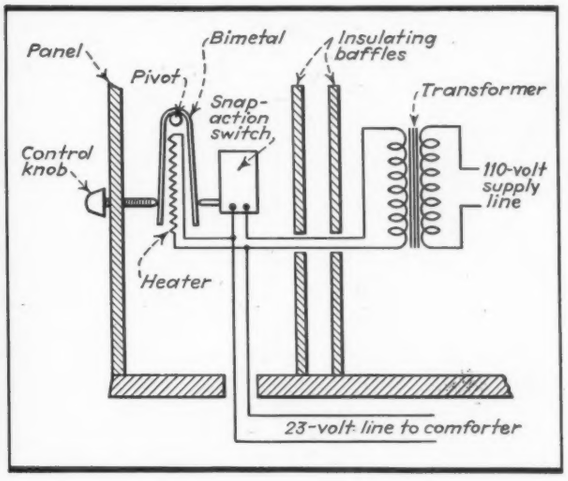


ROTOR AND SHAFT ASSEMBLY is shown at left. Design of the magnet casting is simple and thin sections have been avoided—an important point, since the alloy is very coarse-grained and brittle and since grinding to finished dimensions is the only fabrication operation that can be economically performed on it. Grooves cast in the small diameter of the magnet afford a convenient means of staking the rotor to the shaft, and thus eliminates inserts.

Coil Simulates Controlled Temperature, Adjusts Heat Input

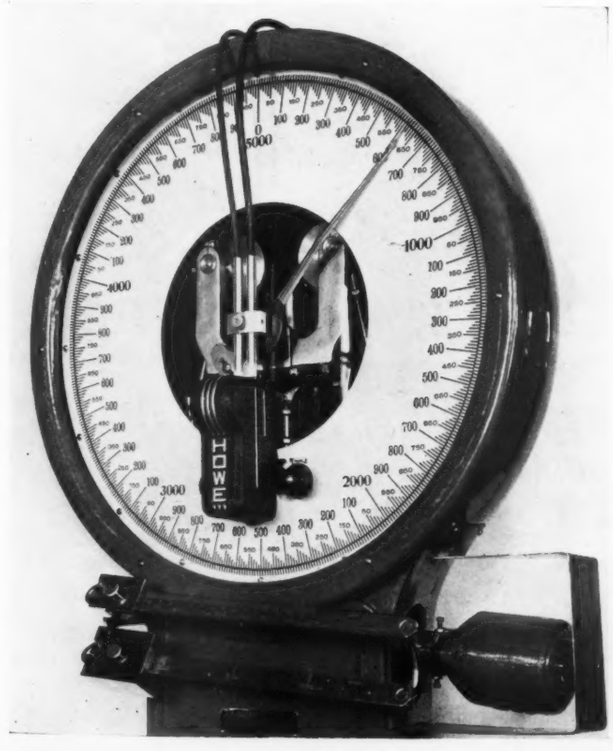
CONTROL UNIT adjusts heat input to General Electric's electric comforter, a light-weight wired "blanket" designed to take the place of heavy bed-clothing. Purpose of control is to maintain constant sleeping temperature by increasing comforter heat as room temperature decreases and decreasing it as room becomes warmer.

BIMETALLIC HORSE-SHOE is heated by resistance coil connected in parallel with comforter element. Characteristics of coil are such that its temperature simulates that of comforter. Thus, as room temperature increases, horse-shoe will expand and actuate micromatic switch, opening circuit. Heater then cools at same rate as blanket and bimetal contracts, turning on switch to maintain desired warmth. Baffles insulate bimetal from transformer heat.



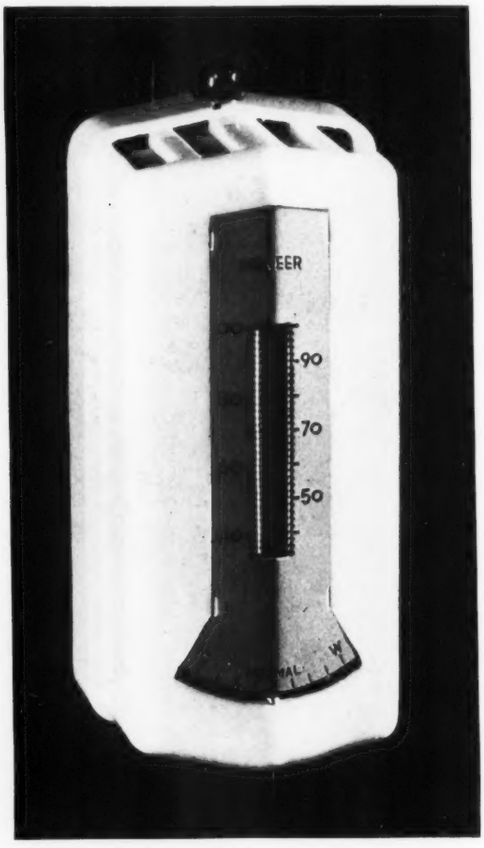
Light Reflection Actuates Photoelectric Cut-Off for Dial Scale

UNIVERSAL MOUNTING makes this cut-off relay, develop for Howe Scale by Lewis C. Barnes of The Electronic Laboratory, easily applicable to any type of dial scale. No alteration in scale is required.



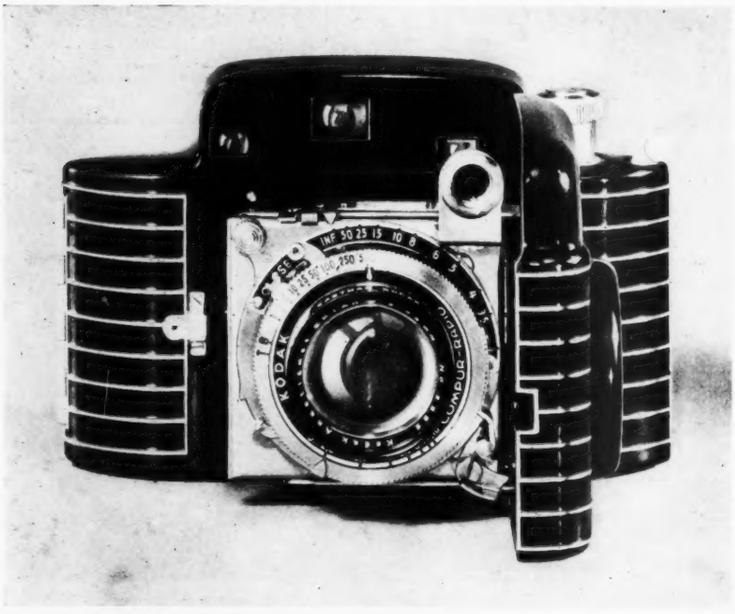
RELAY UNIT is mounted on back of scale and is equipped with pilot lights indicating when relay contacts are open or closed. Optical unit, on front, contains light source and photoelectric cell. It is mounted by suction cups.

BATTERY-OPERATED 'PHONE-SET, with space for dry cell in base, is a development of Universal Microphone. For use either as part of switchboard setup or for inter-office calls, which can be put through merely by depressing button in center of cradle. Device is molded of Durez.

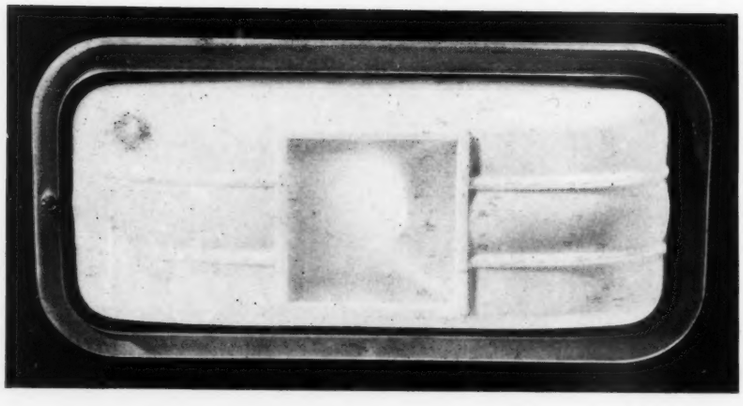


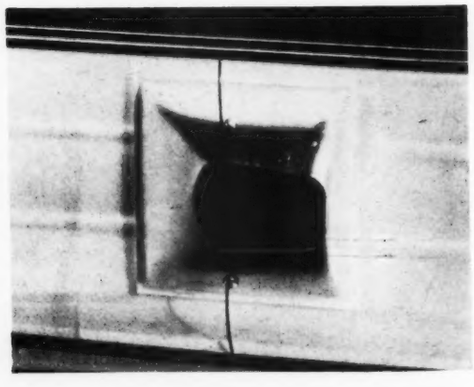
THERMOSTAT WITH PLASTIC CASE, designed by Master Electric, is claimed to be more sensitive and accurate, as well as more attractive, because its case takes up heat more slowly than an equivalent metal case. The case is molded of Plaskon.

CANDID CAMERA, developed by Eastman, has die-cast aluminum body with stainless fittings. Screw machine parts are made of 12- to 15-per cent chrome steel with selenium added for free cutting.



INTERIOR LIGHTING UNIT for buses and railroad cars, designed by Miller Company, is combination of aluminum, glass and translucent plastic, as shown below (with interior view at right). Molded of Beetle.





Group Seven

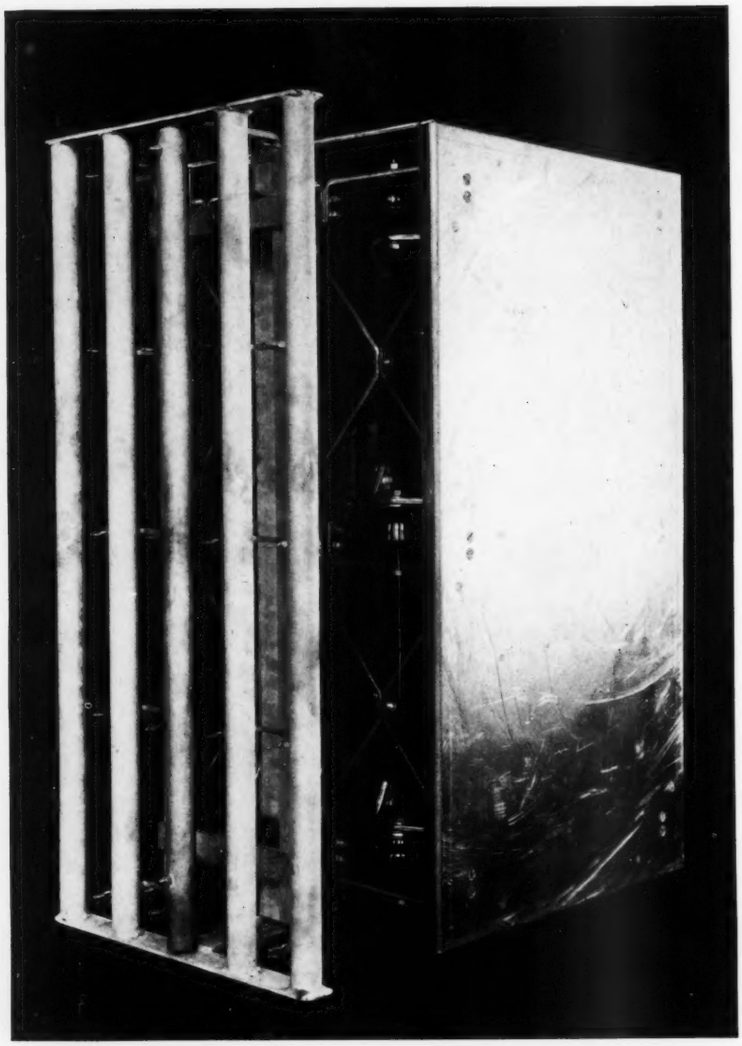
NON-MECHANICAL PRODUCTS

Radios, washing machines, gas and electric ranges, domestic furnaces, home air conditioners, domestic stokers, vacuum sweepers

81 companies reporting

	Per Cent Using	Per Cent Increasing Use
TYPES OF CONSTRUCTION		
Stampings	75	37
Resistance welding	53	26
Die-castings	50	17
Molded plastics	69	15
Fusion welding	37	15
Drawn sections	42	11
Tubular construction	41	9
Roll-formed sheet	41	7
Sand castings	67	5
Wire	42	5
Spinnings	26	5
DRIVES AND CONTROLS		
V-belts	52	22
Resilient motor mountings	28	10
Special motors	21	6
Thermostatic controls	50	6
Variable-speed drives	20	5
Motor speed reducers	18	5
Automatic timers	23	4
Limit switches	37	3
Electrically operated valves	20	3
BEARINGS AND LUBRICATION		
Ball or roller	51	15
Grease-sealed	27	10
"Oilless"	23	4
Grease gun fittings	38	4
Flexible tubing	10	3

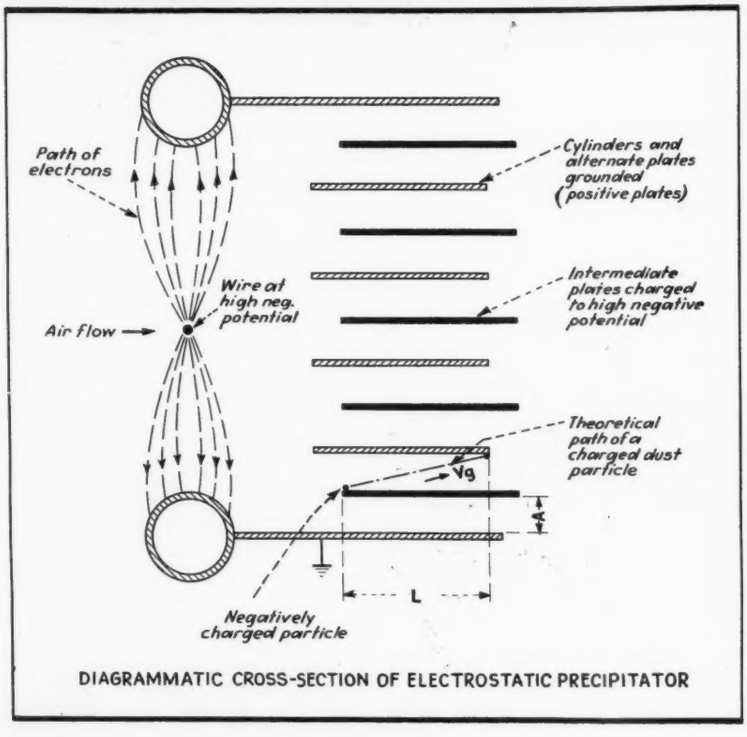
	Per Cent Using	Per Cent Increasing Use
TYPES OF FASTENINGS		
Self-tapping screws	56	17
Unit locking devices	37	9
Hollow head screws	43	5
Drive screws	37	4
MATERIALS OF CONSTRUCTION		
Stainless steel	56	16
Aluminum	73	15
Copper, brass, bronze	63	6
Plain carbon steel	58	6
Zinc	27	6
Alloy cast iron	18	5
Fibrous glass	14	4
Magnesium	11	4
FINISHES		
Chromium plating	55	20
Cadmium plating	57	12
Organic coatings	75	10
Vitreous porcelain	26	7
Chemical coatings	25	4
Metal spraying	18	3



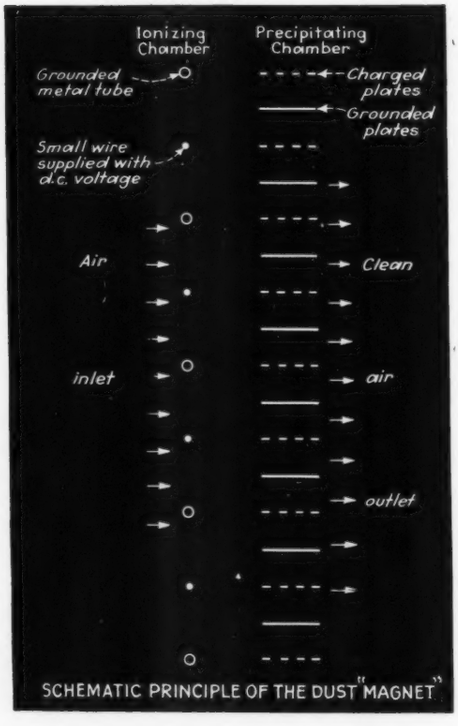
Magnetically Separates Air Impurities

Ions emitted from fine wire charged at 12,000 volts bombard the air in cleaning process developed by Westinghouse Electric & Manufacturing Company

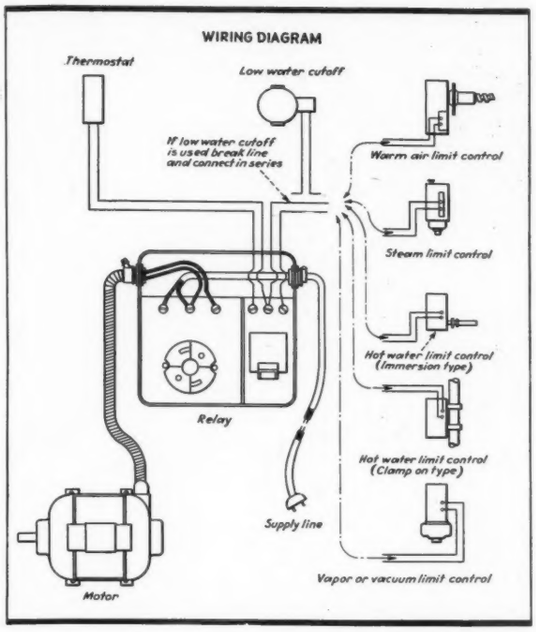
THE PRECIPITATOR consists primarily of a system of cells made up of flat aluminum plates and tungsten ionizing wires. A fan draws the air to be cleaned through the inlet, between a series of grounded metal tubes. One small wire is suspended between each pair of cylinders. These wires are supplied with d.c. voltage generated by a small power pack and create an "electrostatic screen." Bacteria, particles of dust and pollen in the air receive an electrical charge from ions which become attached. The treated air is then drawn through a series of cells consisting of alternately spaced high-potential and grounded plates and the charged particles adhere to the plates. Free of all solid matter the air passes on through ducts to the areas being served. Dirt collected by the units is cleaned off every month or six weeks.


Path of electrons
Cylinders and alternate plates grounded (positive plates)
Wire at high neg. potential
Intermediate plates charged to high negative potential
Air flow
Theoretical path of a charged dust particle
Vg
L
Negatively charged particle

DIAGRAMMATIC CROSS-SECTION OF ELECTROSTATIC PRECIPITATOR

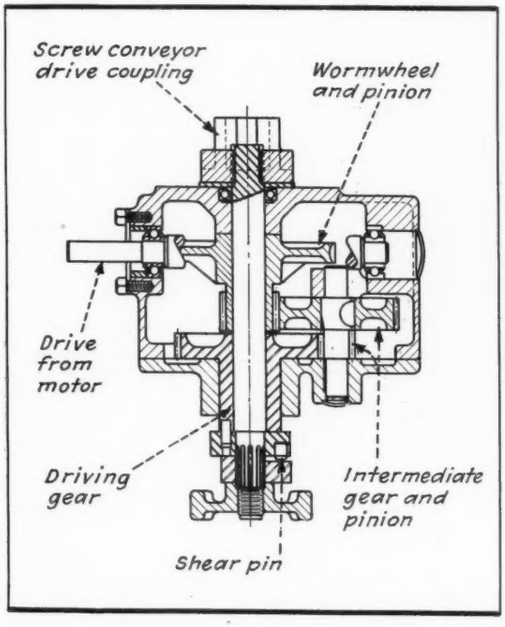


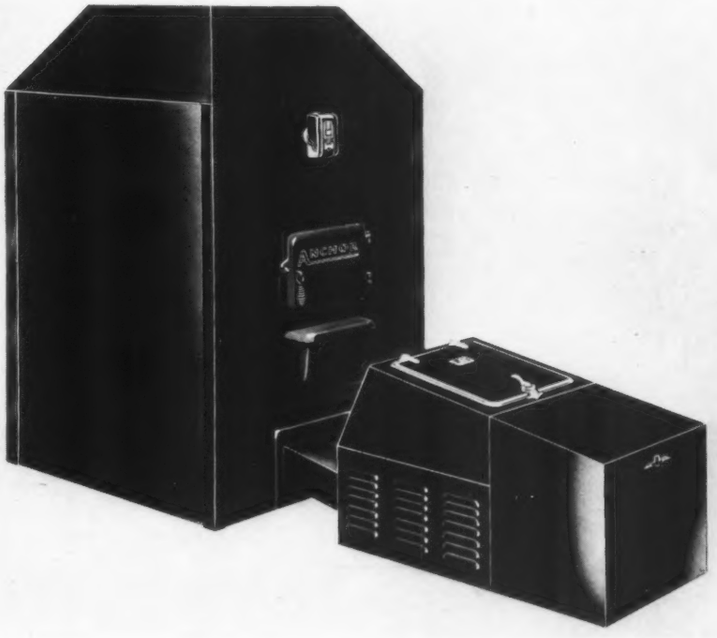
SCHEMATIC PRINCIPLE OF THE DUST "MAGNET"

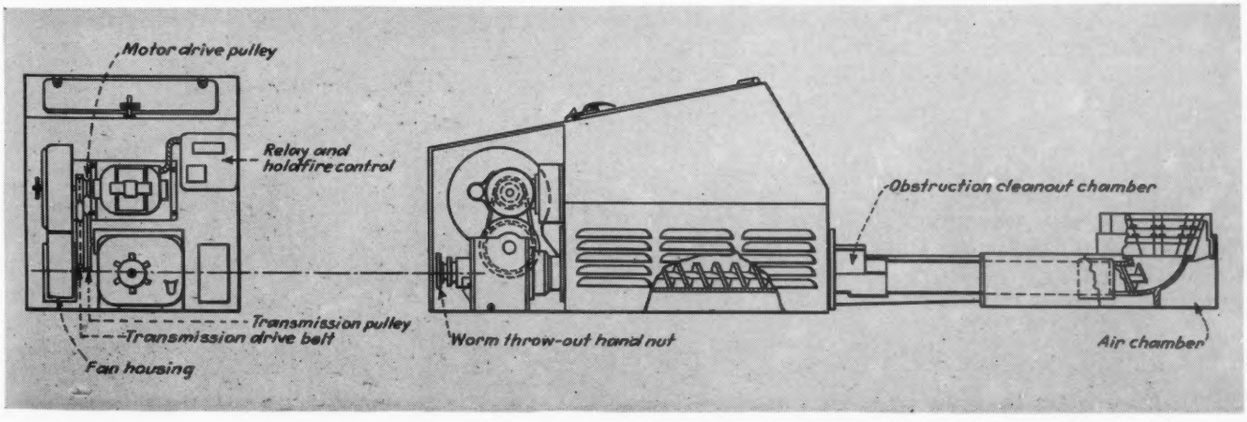


Compact Transmission for Stoker Drive

ALL UNITS OF THE DRIVE and transmissions of the Fire Chief Kolstoker designed by the Anchor Stove and Range Company are housed beneath a sound-proofed steel hood. V-belt transmits power from 1/16 hp. motor to worm on drive unit. Wormwheel mounted loosely on drive shaft has a spur gear pinion integral with it, latter driving a gear with pinion on countershaft, latter meshing with drive gear also loosely mounted on drive shaft. Drive gear connection to its shaft is through a shear pin to a drive collar having a splined fit on drive shaft. Shear pin is easily replaced by loosening worm throwout hand nut. Drive unit is oil sealed, flood lubricated. Motor control is full automatic as shown in wiring diagram. Design permits installation in any existing hand-fired domestic furnace.







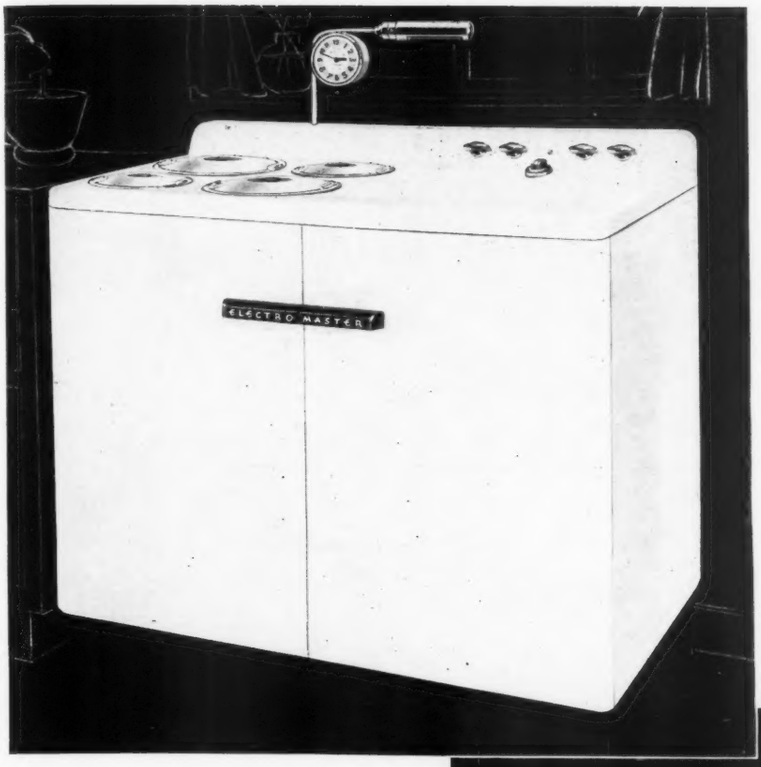
Designing Appearance, Strength and Efficiency into a Compact Electric Roaster

BEFORE DESIGNING the Everhot roasters of the Swartzbaugh Manufacturing Company, chief engineer William P. Von Behren made an extensive market research. One result was the adoption of a rectangular shape that gives approximately 23 per cent more cooking capacity for same table space area and greatly improved proportions. Cover is brass finished with nickel and chromium, body is steel finished with a special synthetic baked enamel compounded for high heat resistance. Food compartments are finished with acid-resisting porcelain enamel having correct thermal expansion so that it does not tend to chip or crack. To keep down weight, sheet gages were held to a safe minimum; embossing at strategic points contributes both rigidity and improved appearance.

Modern Styling and Finishes "Dress" Kerosene Range

WITH ALL CORNERS FULLY ROUNDED and all working parts completely concealed, the wickless kerosene burning Florence table-top range has an aristocratic appearance. The entire outside is finished in vitreous porcelain enamel, the door and burner handles are molded plastic with chromium-plated trim. The pressed steel outer panels are supported by the frame which takes all of the load. Levelling screws are provided so that the range can be set firmly on any floor.

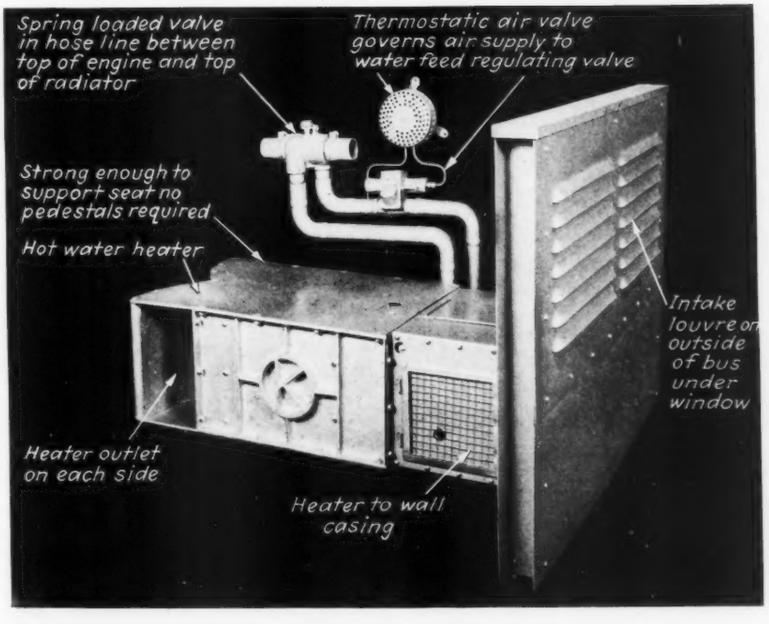
HEAT INSULATED OVEN is finished in porcelain enamel. Dropping the front door gives access to the burner controls, a safety feature being that the door cannot be closed unless the burner controls are in the off position. The two oven burners and the three range burners have individual oil reservoirs located at different levels in the back of the range. Gage glasses indicate oil level in reservoirs. All tubing and piping is resistance welded to avoid any possibility of leakage.



Utensils Fit Into Electric Range, Seal Wells to Conserve Heat

HEATING ELEMENTS placed in wells below working surface, for receiving utensils, feature the new electric range built by Electromaster Inc. The styling was done by Wilbur Henry Adams. Cabinet has swing doors that balance and remain in any position. Equipment includes built-in electric time clock, swinging lamp that illuminates entire top of range, and illuminated oven. The finish is porcelain enamel, handles and knobs are plastics. All switches are mounted on the back plate.

FULL-WIDTH DOORS give easy access to the oven and storage compartment. The interior of the oven is finished in stippled porcelain enamel, rust-proof and easy to keep clean. Spring-clip latches hold the doors closed, requiring only a pull on the molded plastic handle to open them.


Spring loaded valve in hose line between top of engine and top of radiator
Thermostatic air valve governs air supply to water feed regulating valve
Strong enough to support seat no pedestals required
Hot water heater
Intake louvre on outside of bus under window
Heater outlet on each side
Heater to wall casing

Housing of Bus Heater Also Does Duty as Seat Support

DUAL-PURPOSE CASING that also serves as pedestal support, permits this hot water heater to be mounted under a seat near the center of the bus. Double outlets direct warm air both up and down the aisle. A thermostat in the bus controls a pneumatically operated valve that regulates flow of hot water through the heater, the air flow remaining constant. Designed and built by the Kysor Heater Company, the unit not only serves as a heater but also as a forced draft ventilator in the summer, the circulating water then being shut off.

SUMMARY

of Trends in Engineering Design

Based on 506 reporting companies

TYPES OF CONSTRUCTION

First figure—*number of companies reporting use.*

Second figure—*number reporting more extensive use.*

Sand castings	423	59
Permanent mold castings	108	21
Die-castings	193	62
Stampings	286	100
Spinnings	116	12
Roll-formed sections	130	29
Drawn or extruded sections	167	41
Tubular constructions	161	28
Drop forgings	242	54
Malleable iron	210	14
Flame cut parts	195	71
Fusion welding	226	106
Resistance welding	198	70
Molded plastics, rubber	197	53
Laminated plastics	78	9
Vulcanized fiber	71	2
Pressed fiber	87	4
Wire	155	11

MACHINE PARTS AND UNITS

First figure—*number of companies reporting use.*

Second figure—*numoer reporting more extensive use.*

V-belt drives	309	129
Chain drives	180	17
Gear drives	282	40
Speed reducer units	152	32
Variable-speed units, mechanical	116	33
Variable-speed units, hydraulic	32	8
Variable-speed V-belt sheaves	99	22
Flexible shafting	43	4
Flexible couplings	203	20
Magnetic clutches	39	6
Mechanical clutches	190	12
Pneumatically operated clutches	30	3
Motor speed reducer units	129	35
"Shaftless" motors	38	10
Special built-in motors	91	23
Governor-controlled motors	12	2
Torque motors	65	5
Hydraulic pumps and cylinders	96	23
Hydraulic motors	24	4
Magnetic controls	237	38
Limit switches	200	36
Thermostatic controls	155	21
Electronic controls	39	7
Automatic timers	100	17
Electrically operated valves	94	15
Time-temperature or time pressure cyclic controls	35	4
Mercury switches	120	18
Rheostats	113	3
Relays	187	32
Sleeve bearings	276	9
Ball or roller bearings	383	141
"Oilless" bearings	193	30
Grease-sealed ball or roller bearings	246	81
Needle bearings	159	42
Simple oil covers	174	2
Grease gun fittings	287	42
Sight feed oil cups	129	5
Oil circulating pumps	136	36
Central lubricator units	76	11
Oil filters	111	17
Unit bearing seals	123	21
Flexible tubing	74	5
Pressure indicators	153	4
Temperature indicators	147	8
Temperature recorders	58	7
Pressure recorders	36	3
Electric ammeters	76	5
Watt-hour meters	53	2
Power-factor indicators	3	2
Production counters	56	5
Built-in lighting	74	10
Hollow head screws	296	76
Self-tapping screws	189	47
Drive screws	179	25
Nut locking devices	272	45
Resilient motor mountings	108	23
Non-metallic gears	97	8
Plastic housings	33	5
Felt	126	10
Rubber	139	23
Synthetic rubber	75	13
Cork	88	3
Pressed fiber	36	2
Leather	48	3

MATERIALS OF CONSTRUCTION

First figure—*number of companies reporting use.*

Second figure—*number reporting more extensive use.*

Low-alloy high-strength non-heat-treating steels	196	27
Heat-treated alloy steels	222	107
Stainless strip or sheet	187	37
Stainless steel castings	68	12
Nitralloy	84	12
Cast iron	375	24
Alloy cast iron	241	78
Malleable iron	219	19
Copper, brass or bronze	351	30
Monel	120	14
Beryllium copper	57	10
Aluminum	322	55
Magnesium (Dow Metal)	57	17
Clad sheets	37	6
Laminated metals such as thermostatic bi-metals	47	8
Hard facing materials	65	16
Zinc	111	28
Plastics	132	28
Molded rubber parts	137	17
Fibrous glass	29	4
Plywood	64	2
Metal-faced plywood	16	1
Rare metals	26	3

FINISHES

First figure—*number of companies reporting use.*

Second figure—*number reporting more extensive use.*

Chemical coatings	158	19
Organic coatings	310	38
Vitreous porcelain enamel	57	8
Electroplating—cadmium	241	41
Electroplating—nickel	152	10
Electroplating—chromium	217	68
Metal spraying	63	11
Anodic coatings (Alumilite)	62	12
Metallic nameplates	254	26
Decalcomanias	148	8
Prefinished sheets	36	3